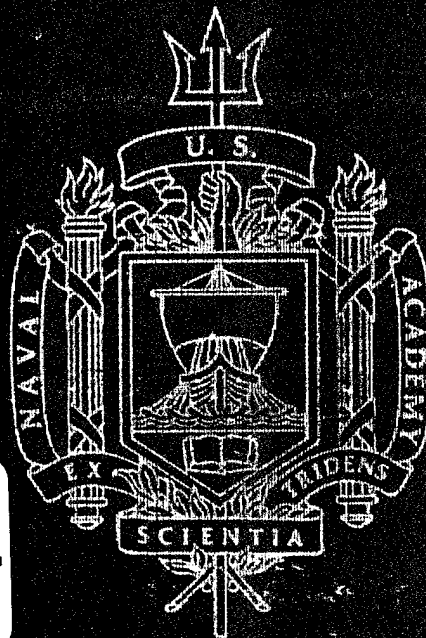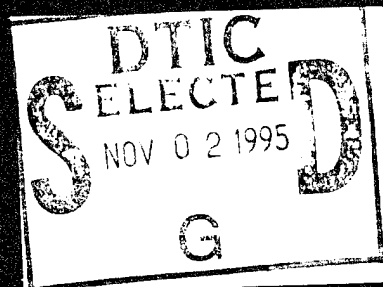SUMMARY OF

RESEARCH

ACADEMIC DEPARTMENTS

OCTOBER 1994

OFFICE OF THE ACADEMIC DEAN

UNITED STATES NAVAL ACADEMY

ANNAPOLIS, MARYLAND

SUMMARY

OF

RESEARCH

1993-1994

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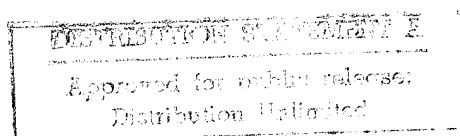COMPILED, EDITED AND TYPESET

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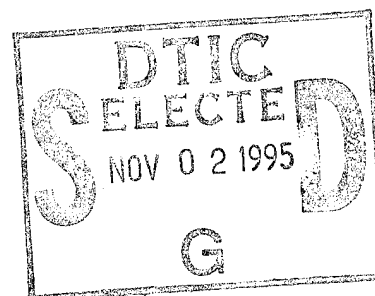
OCTOBER 1994

UNITED STATES NAVAL ACADEMY

ANNAPOLIS, MARYLAND
21402

USNA-3910-3

Foreword

Naval Academy policy is to maintain an atmosphere in which research contributes to the professional growth of both midshipmen and faculty. Research has a double benefit at the Naval Academy, not only enhancing scholarship but also contributing to national technical excellence.

In the two decades since the Research Office was created, progress can be measured by the growth in research participation, budgets, papers, books and presentations, shown in figures 1, 2 and 3. Naval Academy faculty and midshipmen have seized the opportunities to do research provided by local facilities, research courses, sabbaticals and travel support and to contribute to classroom enhancement through curriculum and pedagogical development. The information presented in this report describes the research projects and productivity of our faculty and midshipmen for the 1993-1994 academic year. Each of sixteen academic departments in four divisions presents the details of its efforts.
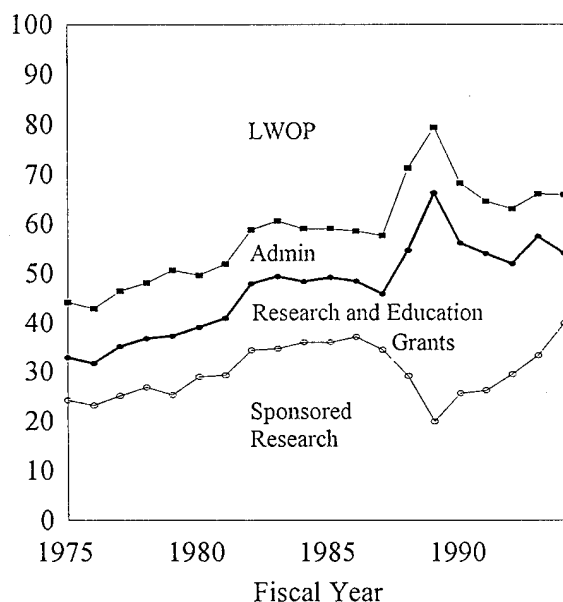
USNA Research Budget
Thousands of Dollars

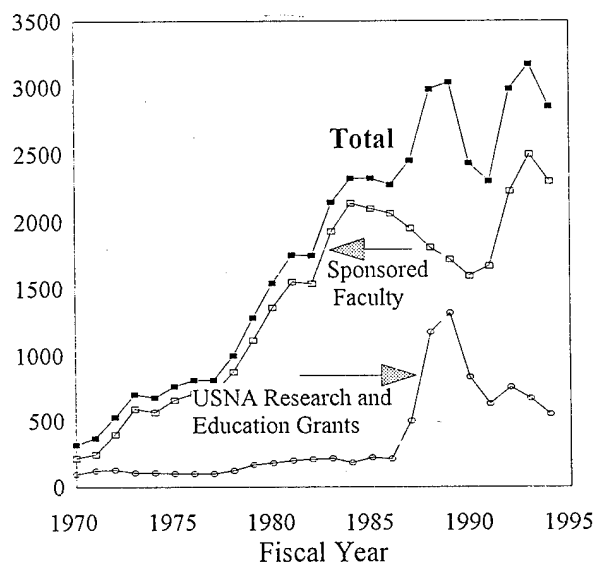**Figure 2.** Growth of the research budget since 1970 includes sponsored faculty projects and Naval Academy programs.

Faculty Intersessional Activities
Percent

Figure 1. The fraction of faculty in sponsored research reached a record high in fiscal year 1994.

Overall research funding included 6% O&M,N funds, 75% Navy, 4% DoD, 9% federal and 6% private funds. This distribution reflects minimal institutional support and growing joint services and private funding consistent with national trends. Our major reimbursable sponsor, after the Chief of Naval Research, is the Naval Surface Warfare Center whose $509k supported 31 faculty. Naval laboratories funded a record 62 faculty members research this year for a total of $884k under the Chief of Naval Research Memorandum of Understanding. Reimbursable research funds reached $2353k, funding a record 102 faculty while the total FY94 research budget declined to $2.9 million. Faculty are encouraged to progress from internal to external research sponsorship.

Midshipman participation in research at the Naval Academy continues with 74 research courses and 50 Systems Engineering design projects,

although all engineering majors complete a design project. There were 13 Trident Scholars (12 selected for the class of 1995), 61 midshipmen who used their leave to work with a dozen Navy, Dod, and federal agencies, and 93 travelling abroad under the Cox foreign language program.

Several Cooperative Research and Development Agreements (CRADAs) are being developed as faculty become more familiar with Technology Transfer. Research chairs were sponsored by the Naval Space Command, the National Oceanographic and Atmospheric Administration and the National Aeronautics and Space Administration; two postdoctoral fellows sponsored by the Office of Naval Research also chose to join our faculty for a period of teaching and research. Their active dialogue with our faculty and midshipmen is an essential part of our national participation.

Faculty research is recognized nationally, with twelve books published in the English, Political Science, Mechanical Engineering and Mathematics Department. Research at the Naval Academy continues to serve both our educational and professional missions.

Research Productivity
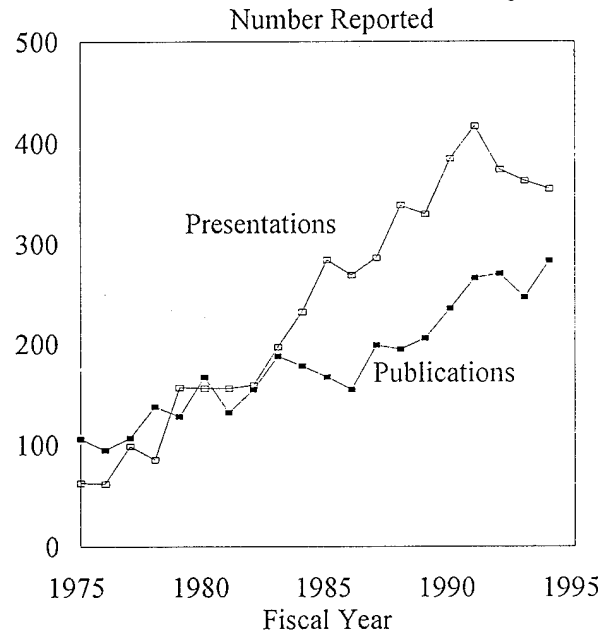### Number Reported

Figure 3. Faculty productivity in publications and presentations has increased significantly.

ROBERT H. SHAPIRO
Academic Dean and Provost

CARL S. SCHNEIDER
Director of Research

Contents

Division of
Engineering and Weapons

Captain Todd W. Bruner, USN
Director

Aerospace Engineering

Professor Maido Saarlas
Chair

F aculty and midshipmen research in the Aerospace Engineering Department covers many areas of specialization. These include research on unmanned low-speed aircraft, remotely piloted vehicles (RPVs), and communication problems with space shuttles.

Research is supported mainly through funds from government agencies such as the National Air and Space Administration, the Naval Research Laboratory, the Naval Air Warfare Center, and the Naval Space Command. The Naval Academy Research Council provided laboratory matching funds for faculty research during the summer intersessional. This sponsored research provides benefit to its various sponsors and keeps the faculty current in state-of-the-art engineering practice. In addition, faculty participation in current development and research in the field of aerospace engineering has enhanced the learning process in the classroom, from the most fundamental courses to the final capstone design course.

Sponsored Research

Use of Computers in Spacecraft Design

Researcher: Professor William J. Bagaria
Sponsor: Naval Space Command

Over the last several years, efforts have been uderway to bring the computer aided design programs into the classroom as a design tool for the midshipmen. These programs are complex and run on engineering workstations. The purpose of this research is to determine the most usable programs for the classroom environment, and to produce tutorial materials for use by the midshipmen.

Unmanned Vehicle Development

Researcher: Professor Bernard H. Carson
Sponsor: Naval Research Laboratory

This project required the design, construction, and flight testing of an electric powered, radio-controlled aircraft for the Naval Research Laboratory. Unique to this aircraft is the requirement that it fly from an energy source consisting of a ground-based laser tracking device. This aircraft was successfully flown on internal power, but the laser energy tests were postponed due to technical difficulties experienced by NRL.

2

CoAxial Propeller/Rotor Interaction Investigation

Researcher: Associate Professor Gerald F. Hall
Sponsor: National Aeronautics and Space Administration/
Ames Research Center

A computer code capable of analyzing axial inflow performance and evaluating of the merits of the prop-fan/tilt rotor propulsion system. This code, utilizing unsteady vortex lattice techniques, will analyze the system in hover and will also provide high speed, initially subcritical, prop-fan cruise information.

An experimental investigation of the prop-fan/tilt rotor system will be carried out utilizing the rotor stand at the U. S. Naval Academy. The full scale hover stand will provide thrust and power data as a function of vertical spacing between the rotor and prop-fan configurations, differential rotation of the two components, and power ratio.

Effect of Leading-Edge Trailing Edge Flap Oscillations on the Aerodynamic Response of an F-18 Wing Model

Researchers: Associate Professor Gabriel N. Karpouzian, and
Midshipmen 1/C Dan Gordon, USN and Midshipmen 1/C Peter McArdle, USN
Sponsor: Naval Air Warfare Center

An F-18 wing model has been built at the Naval Academy with leading-edge (LE) and trailing-edge (TE) flaps which are allowed to oscillate at various frequencies and amplitudes in and out of phase. The objective of the work is to study their coupled effects on the aerodynamic response of the wing in a low-speed wind tunnel in order to determine the optimum mode(s) of oscillation for which the unsteady lift to drag ratio can be enhanced. The proposed work is a two-phase project. The first phase, which is currently under way, involves the manufacturing process of the wing. The second phase will involve the wind-tunnel testing of the model and the subsequent analyses of the aerodynamic response.

Office of Naval Research Postdoctoral Fellowship

Researcher: Postdoctoral Fellow Charles A. Lind
Sponsor: Office of Naval Research

Current research is directed towards fulfilling the requirements of the Office of Naval Research Postdoctoral Fellowship.

In order to better understand the unsteady characteristics of the type IV shock interaction, additional research is currently being performed. The goal of the current research is to undertake additional efforts which will lead to a more thorough understanding of the unsteady phenomena associated with the type IV shock interaction. The first issue which is being addressed is the effect of a full Navier-Stokes solution on the interaction. Turbulence, especially in regions near the shear layer and the jet impingement point, and how turbulence will influence the frequency and magnitude of the supersonic jet unsteadiness will also be addressed. Euler calculations will also be necessary so that a comparison of the three major flow regimes. Euler, laminar, and turbulent can be compared and contrasted. The limiter presently used in the TVD type algorithm is a minmod type limiter. The effect of other limiters, such as the van Leer or superbee, also needs to be examined. The effect of Reynolds number and Mach number on the frequency of oscillation of the supersonic jet also needs to be further examined. Finally, if there exists any correlations between 1.) Mach number, 2.) Reynolds number, 3.) and Strouhal number these should be determined.

A Detailed Analysis of the Type IV Shock Interaction

Researcher: Postdoctoral Fellow Charles A. Lind
Sponsor: Office of Naval Research

A thin-layer approximation to the two-dimensional Navier-Stokes equations, coupled with the total variation diminishing (TVD) scheme, is used to examine a type IV shock interaction at Mach 8. The calculations reveal that the apparent unsteadiness of the type IV interaction is related to the formation and shedding of shear layers within the shock layer and acoustical feedback between the distorted bow shock and the body. A Fourier analysis of the flowfield indicates that this shedding frequency is the same frequency associated with the motion of the supersonic jet. The effects of shock impingement angle and shock strength on the location and magnitude of the peak pressure are also studied, and it is shown that small changes in the impinging shock angle can strongly affect the peak surface pressure and the supersonic jet position. Further examination of the unsteady behavior of the interaction reveals that a small change in the impinging shock angle can change the flow field from steady to unsteady.

Feasibility of Very Large Seaplanes

Researcher: Professor Richard D. Mathieu
Sponsor: Naval Air Warfare Center

Initiated a feasibility study for the mission and design of very large seaplanes (over one-million pounds). A bibliography was developed. Design data was gathered and extrapolated. A variety of design concepts were explored. Three preliminary designs were developed by midshipmen in Aerospace Vehicle Design course.

Optical Properties of Photo Refractive Crystals

Researchers: Visiting Professor James G. Severns and
Midshipman 1/C Todd Huber, USN
Sponsor: Naval Research Laboratory

This project naturally divided into two phases: a study phase during which understanding of the properties of photo refractive crystals was gained, then followed by an experimental phase where the optical gain dependence on laser beam coupling was to have been characterized. The study phase went well, but the experimental phase was to attempt. Experimental results have stll not been completed to the satisfaction of the researcher.

Magnetic Compatibility of the High Temperature Superconducting Space Experiment (HTSSEII)

Researcher: Visiting Professor James G. Severns
Sponsor: Naval Center for Space Technology at
Naval Research Laboratory

Magnetic interactions of several critical components of the High Temperature Super Conducting Space Experiment (HTSSE-II) were studied, predictions of the level of such interactions were made, and advice given on which might negatively affect spacecraft operation. The experiment operates at a temperature of 80 degrees K, which will be provided in space by several sterling cycle refrigerators. These refrigerators contain strong permanent magnets which oscillate when in operation, producing time varying magnetic fields. Sensitive measurements of the ambient geomagnetic field will be used to sense spacecraft attitude, and magnetic devices known as "Torque Rods[1]" will occasionally produce strong magnetic pulses to correct the attitude by coupling with ambient field. The interaction of all these components was studied so that solutions to serious

problems could be planned well in advance of building the experiment. Magnetic fields produced by the refrigerators and torque rods were modeled mathematically using a dipole and quadrupole expansion, then level of interactions estimated. It was found that the field due to the torque rod would have no important affect on the operation or reliability of the refrigerators, but that the refrigerators could seriously degrade the operation of the magnetometer which measured the ambient field. Plans were made to mount compensation magnets of suitable strength on each refrigerator.

1. Torque Rod is a registered trademark of the Ithaco Company.

Independent Research

Removal of Hip Femur Prosthesis

Researcher: Professor William J. Bagaria

As hip joint replacement becomes more common, it has been discovered that about 10% of the prostheses have to be removed and replaced within ten years. When the prosthesis is first implanted, every effort is made to insure that it will not loosen. This in turn makes it very difficult to remove it if this becomes necessary. This project involved the pullout testing of hip replacement femoral prosthesis. The research was a joint project with the Walter Reed Army Medical Center.

Vehicle Tripping in Steady State Turns

Researcher: Professor William J. Bagaria

Several rollover metrics, such as Static Stability Factor, Tilt Table Ratio, and Slide Pull Factor, are used to rank vehicles as to their rollover propensity. In certain applications, such as steady state cornering for vehicles with moderate to high centers of gravity, these metrics can be used to predict rollover speeds in situations in which they do not apply. These metrics cannot be used for vehicles with low centers of gravity and those with "wide" tires compared to the vehicle half-track-width in the transient cornering case, where the lateral acceleration changes suddenly compared to the body roll rate. This research involves the comparison of transient rollover speeds, as predicted by computer simulations to those predicted by the rollover metrics.

Hull-Superstructure InteractionGeneric Models, Preprocessor, Numerical and Experimental Models, and Parametric Studies

Researcher: Assistant Professor Michael D. A. Mackney

The assessment of the interaction of the superstructure with the hull of a ship is an important part in the determination of the longitudinal strength and an essential part of the design process.

The study of hull-superstructure interaction and related topics has been the subject of many researchers' efforts and papers for a long period, using classical theoretical, experimental and numerical methods to measure and predict the behavior. No one appears to have examined the relationship from a parametric viewpoint, determining which factors influence the behavior most. A series of generic models of simplified and likely configurations of one and two-superstructure arrangements were designed, supporting data generating preprocessors were written to produce a large number of error-free data sets to run with the GIFTS finite element processor.

An experimental study using six acrylic models validated aspects of the numerical behavior for both bending and torsional loadings. An additional series of

numerical studies based on simple beam and plane models reinforced the results from the previous three dimensional studies. A superstructure effectiveness was defined as the comparison in maximum hull displacement without to a superstructure. Design curves were produced showing the variation of effectiveness with length and position of the superstructure for both single and double arrangements.

This work, limited by the ability to run large numbers of finite element models on engineering work stations, nevertheless has shown the importance of suitable models and preprocessors, and the suitability of one-dimensional and plane approximations to three-dimensional structures that possess planar symmetry. The results show that single superstructures are the most effective for a given size and that multiple arrangements are better than two separate units, which appear to be the worst arrangement. The superstructure, even of modest dimensions, adds considerably to the total cross section second moment of area, which is a key factor in the determination of the superstructure effectiveness. This effectiveness is reduced for the bending and shear loading studies undertaken.

Several hundred different finite element analyses were undertaken with effectiveness being judged from displacement data only. Because a post-processor had not been implemented, the very large amount of stress data have not been examined yet in a parametric presentation.

The study has shown that the finite element method is a suitable solution method in parametric studies when other methods cannot embrace the range of variables present.

Publications

BRAY, Robert M., Captain, USMC, "Integrating Flight Simulation and Analysis Into Undergraduate Aircraft Design," ASEE '94 Conference Proceedings, 1994 Annual Conference Proceedings, (26-29 June 1994), 19-23.

Flight simulation was used to actively involve undergraduate students in the flight testing, analysis, and redesign of their conceptual aircraft designs. Flight simulation was integrated into the capstone aircraft design course at the U.S. Naval Academy to enable the students to test fly their conceptual aircraft designs after calculating the aircraft's stability and control derivatives, weights, and dimensions. Flight-testing methodology was introduced, and previously completed courses such as flight performance, stability and control, and control theory were brought together through flight simulation and subsequent analysis of the test flights. Flight simulation provided real-time feedback to the students. Flight parameters were recorded for subsequent analysis of handling qualities, dynamic response, and center of gravity limits. Flight simulation generated student enthusiasm and friendly competition between design teams.

KARPOUZIAN, Gabriel N., Associate Professor, Coauthor, "Three-Dimensional Flutter Solution of Aircraft Wings Composed of Advanced Composite Materials," *AIAA* , (April 1994), 94-1490.

A powerful solution methodology enabling one to derive the 3-D flutter solution of aircraft wings composed of advanced composite materials is presented. In this context, a refined structural model for aircraft wings incorporating the effects of warping inhibition, transverse shear flexibility and anisotropy is used. Based on this model, the flutter instability of both straight and swept wing aircraft is considered.

KARPOUZIAN, Gabriel N., Associate Professor, Coauthor, "Finite-Time Thermodynamics and Endoreversible Heat Engines," *The International Journal of Mechanical Engineering Education*, Vol. 21, No. 4, (October 1993), 337-346.

An endoreversible heat engine is an internal reversible and externally irreversible cyclic device which exchanges heat and power with its surroundings. Classical engineering thermodynamics is based on the concept of equilibrium. Time is not considered in the energy interactions between the heat engine and its environment. On the other hand, although rate of energy transfer is taught in heat transfer, the course does not cover heat engines. The finite-time thermodynamics is a newly developing field to fill in the gap between thermodynamics and heat transfer. Two types of engines are modelled in this paper--a reciprocating and a steady flow--with results obtained for maximum power output and efficiency at maximum power. It is shown that the latter is the same for both types of engines but that the

maximum value of power production is different.

LIND, Charles A., Postdoctoral Fellow, "Unsteady

Effects of a Hypersonic Type IV Shock Interaction," 30th AIAA/SAE/ASME/ASEE Joint Propulsion Conference, *AIAA* ,(June 1994), 2945.

This work describes the effect of viscosity on the unsteady behavior of a Mach 8 type IV shock interaction. The thin-layer approximation to the two-dimensional Navier-Stokes equations as well as the two-dimensional Euler equations, coupled with the total variation diminishing (TVD) scheme, are used to analyze this phenomena.

The inviscid and viscous calculations show that the peak surface pressure, the impingement location of the supersonic jet, and the time required for the development of the interaction are strong functions of the impinging shock location. The frequency of oscillation of the supersonic jet is also shown to be proportional to the strength of the impinging shock.

Preliminary work also indicates two mechanisms are responsible for the unsteady behavior of the interaction. The first is associated with the transients and are related to the formation and shedding of shear layers within the shock layer and the second is due to the instability of the terminating shock associated with the supersonic jet.

LIND, Charles A., Postdoctoral Fellow, Coauthor, Mark J. Lewis "A Numerical Study of the Unsteady Processes Associated with the Type IV Shock Interaction," 29th AIAA/SAE/ASME/ASEE Joint Propulsion Conference, (June 1993), *AIAA*, 2479.

A time-dependent ADI formulation of the two-dimensional Navier-Stokes equations coupled with the total variation diminishing (TVD) scheme is used to examine the type IV shock interaction time accurately. The experimentally measured and computationally calculated unsteadiness of the type IV interaction is shown to be related to the formation and shedding of shear layers in the shock layer, and the frequency of oscillation of the jet is a strong function of the shedding rate of these shear layers. For one particular geometry, an oscillation frequency of 1.4 kHz was calculated. The effects of shock impingement angle and shock strength on the location and magnitude of the peak pressure are also identified. In one case it is shown that a one degree change in the impinging shock angle can alter the location of the associated jet by almost 11 degrees with a change in the peak surface pressure of 32 percent.

MACKNEY, Michael D. A., Assistant Professor, *Hull-Superstructure Interaction - Generic Models, Preprocessors, Numerical and Experimental Models and Parametric Studies*, Doctor of Philosophy Thesis,

University of Portsmouth, England, (July 1993).

The assessment of the interaction of the superstructure with the hull of a ship is an important part in the determination of the longitudinal strength and an essential part of the design process.

The study of hull-superstructure interaction and related topics has been the subject of many researchers' efforts and papers for a long period, using classical theoretical, experimental and numerical methods to measure and predict the behavior. None appears to have examined the relationship from a parametric viewpoint, determining which factors influence the behavior most. A series of generic models of simplified and likely configurations of one and two-superstructure arrangements were designed, and supporting data generating preprocessors were written to produce a large number of error-free data sets to run with the GIFTS finite element processor.

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This work, limited by the ability to run large numbers of finite element models on engineering work stations, nevertheless, has shown the importance of suitable models and preprocessors and the suitability of one-dimensional and plane approximations to three-dimensional structures that possess planar symmetry. The results show that single superstructures are the most effective for a given size and that multiple arrangements are better than two separate units, which appear to be the worst arrangement. The superstructure, even of modest dimensions, adds considerably to the total cross section second moment of area, which is a key factor in the determination of the superstructure effectiveness is reduced for the bending and shear loading studies undertaken.

Several hundred different finite element analyses were undertaken with effectiveness being judged from displacement data only. Because a post-processor had not been implemented, the very large amount of stress data have not been examined yet in a parametric presentation.

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Presentations

BRAY, Robert M., Captain, USMC, "Integrating Flight Simulation and Analysis Into Undergraduate Aircraft Design," ASEE Annual Conference, Edmonton (Alberta), Canada, 25-29 June 1994.

BRAY, Robert M., Captain, USMC, "Integrating Flight Simulation and Analysis Into Undergraduate Aircraft Design," ASEE '94 Conference, Session 0402, University of Illinois, Urbana-Champaign, 20-24 June 1994.

BRUNINGA, R. E., "Ground Station Tracking Via Packet," Annual AMSAT Symposium, *The AMSAT Journal* June 1993, Washington DC, October 1993.

BRUNINGA, Robert E., "Using GPS for Balloon Payload Tracking," Proceedings of the Edge of Space Sciences, National Balloon Symposium, Salt Lake City, Utah, 20-22 August 1993.

KARPOUZIAN, Gabriel N., Associate Professor, "Three-Dimensional Flutter Solution of Aircraft Wings Composed of Advanced Composite Materials," 35th Structures, Structural Dynamics, and Materials Conference, Hilton Head, South Carolina, 18-20 April 1994.

Electrical Engineering

Colonel James F. Kendrick, USAF
Chair

R esearch and scholarly activity are fundamental to the vitality and viability of any discipline. This is particularly applicable to electrical engineering, which is broadly based and rapidly expanding. Research helps both faculty and midshipmen keep abreast of advancing technology and ultimately improves the effectiveness of the academic environment by encouraging a modern and relevant curriculum.

Funding for our research comes from the Naval Research Laboratory, the Naval Surface Warfare Center, the Defense Nuclear Agency, and from within the Naval Academy. Research topics supported during the past year included SPICE Simulation of a Transmission Line Model of the Ear, Synergistic Effects of Temperature on COMS Threshold Shifts during Ionizing Irradiation, Developing On-Board Intelligence for an Omni-Directional Vehicle, Asynchronous Serial Communication Between Two Microcomputers, Neural Network IRST Tract Evaluation, and Harmonic Distortion in Current Controlled Pulse-Width-Modulation Inverters. This faculty research contributes directly to the Fleet's operational capabilities and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

Sponsored Research

Synergistic Effects of Temperature on CMOS Threshold Shifts During Ionizing Irradiation

Researcher: Professor R. L. Martin
Sponsor: Naval Research Laboratory

This research investigated temperature effects on CMOS inverter threshold shifts during ionizing radiation. The studies were directed toward commercial non-hardened inverters since some existing and planned systems used in space applications use these devices. Earlier studies have shown that increased temperatures have an effect similar to time scaling, a concept that has previously been applied to predict low dose rate performance from high dose rate testing. CMOS FETs were irradiated at various temperatures at a low dose rate representative of space radiation rates and at high dose rates representative of tactical situations. An approximate subthreshold slope technique was used to separate the amount of threshold shift due to oxide trapped charge from the amount due to interface trapped charge. The method was first applied to N-channel FETs which were pinned out separately from the P-channel FETs in commercial CMOS CD4007 ICs and then compared to N-channel FETs which were configured as part of CMOS inverters. The method was then applied to P-channel FETs which were configured similarly. It was found that, for low dose rate irradiation, the shifts due to interface trapped charge increased with temperature while the shifts due to oxide trapped charge were independent of temperature, but for high dose rate irradiation there was no discernible difference with temperature.

Developing On-Board "Docking" Intelligence for an Omni-Directional Vehicle

Researcher: Assistant Professor Kelly A. Korzeniowski
Sponsor : Naval Air Warfare Center, Lakehurst, NJ

The Omni-Directional Vehicle, (ODV), developed by NAWC Lakehurst, NJ and Oak Ridge National Laboratories, Oak Ridge, TN, is a highly maneuverable mobile robot base capable of transporting heavy payloads. The ODV was designed to be used on flight decks to transport engines, missiles, etc. At present, the ODV is tethered to a joy stick. The project is now at the stage where on-board intelligence is being incorporated to facilitate autonomous mobility.

The purpose of this project will be to design a "local navigation" controller and a "goal recognition" system for the ODV. The purpose of the "local navigation" controller will be to precisely move the ODV to a local goal that has been identified by the "goal recognition" system. A possible scenario is that the ODV has already been moved across the flight deck and is now located near a group of aircraft. The instruction is to locate a specific aircraft and move toward it in order to perform a task.

At this time work on the project has begun and the facilities at the Naval Academy will be used in order to test the algorithms that will be used on the ODV. By implementing the modular algorithms in the Systems Robot Lab at the Naval Academy, it will be shown that the algorithms do work in a real world robotic system.

Motor Current Signal Analysis for Diagnosis at Fault Conditions in Shipboard Equipment

Researcher: Midshipman. 1/C Johnathan Adam Siegler, USN
Adviser: Professor Antal A. Sarkady
Sponsors: Trident Scholar Program and Naval Surface Warfare Center, Annapolis, MD

In the Navy it is imperative that systems and equipment work at their peak performance levels. Man-hours, money, and even lives may depend on it. On a submarine, it may even be more important, because fault conditions in equipment can lead to increased noise levels, which result in a higher probability of detection by the enemy. There are inherent problems associated with detecting fault conditions in shipboard equipment. Most importantly, equipment must often be shut down and taken apart. This can cost countless man-hours and down time that an underway vessel cannot afford. In addition, the equipment may be located in an area that is very difficult or impossible to reach under normal circumstances. This would include all equipment found in the primary plant of a nuclear powered submarine.

Motor current signal analysis provides a solution to these problems. It is a non-invasive technique for monitoring and diagnosing mechanical problems associated with equipment driven by electrical motors. The objective of this project was to implement this process by examining the electrical power signal supplied to a Byron Jackson main sea water pump found in a U.S. submarine and to develop signal processing routines and classification techniques to distinguish between the pump working with a good impeller and the pump working with an eroded impeller. Although this one fault condition was studied, this research sought to develop a method by which other fault conditions could be detected.

Results of this study clearly shows that it is possible to identify and classify eroded impeller conditions in a main sea water pump operating under normal conditions.

Neural Network Infra-Red Search and Track Evaluation

Researcher: Associate Professor David S. Harding
Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

Data from aircraft based infra-red sensors can be used to detect and track potential threats and targets. Presently a Bayesian approach is used to perform track evaluation on infra-red search and track (IRST) data gathered at Naval Air Warfare Center. The task of the evaluator is to detect and track a target in the presence of clutter. Work was

done on this project over the summer and fall of 1993 to investigate the use of neural networks to evaluate IRST data. The dimension of time is represented to the input of a neural net by concatenating as many as nine or more consecutive frames of data to be input at once.

Preliminary results indicate that the neural net method performs better than the Bayesian approach. The next phase of the project is to test the neural net method sensitivity when variating IRST data. The ability of a neural net to correctly generalize given data that spans the entire range of possible IRST measurements must be determined.

Harmonic Distortion in Current Controlled Pulse-Width-Modulation Inverters

Researcher: Assistant Professor Brian K. Butka
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This work investigated the performance of several Pulse Width Modulated(PWM) inverter systems under a variety of loading and filtering conditions. The baseline system consisted of a variable-frequency PWM system with a Tee filter driving a resistive load. The performance of the baseline system was analyzed analytically and by using single-phase models based in PSPICE. The effect of filter component values was then investigated and filter design rules of thumb were proposed. In addition, a fixed-frequency PWM system was investigated and found to have superior performance compared to the variable-frequency PWM system under most operating conditions. Advanced Computer Simulated Language(ACSL) simulations were used to confirm the accuracy of the PSPICE simulations.

Study of the Temperature and Frequency Dependencies of the Electrical Characteristics of Metal-Oxide Ceramics

Researcher: Assistant Professor Ralph W. Bruce
Sponsor: Naval Academy Research Council

Processing materials with microwave energy has found widespread use in the commercial and domestic processing of foodstuffs. Of more recent origin has been the use of microwave energy for the processing of engineered plastics and ceramics. In order to adequately model the thermal and electrodynamic behavior of a material as it is being processed, knowledge of the temperature and frequency dependent characteristics of the material must be known. This interaction of a material as the load in a microwave system is highly dependent upon the electrical characteristics of the microwave system and those of the material. Therefore, in order to adequately control the processes associated with microwave heating and sintering of metal-oxide ceramics, a model must be developed to test proposed metal-oxide systems and the electrical systems that will be used to perform the sintering.

Independent Research

Asynchronous Serial Communication Between Two Microcomputers

Researcher: Professor Tian S. Lim

This project implements a full asynchronous serial interface between two microcomputers. It details the design and test of a two-way, one line message display arrangement between two machines. The arrangement allows the user to send a message from the transmitting machine to the receiving machine and the message will appear simultaneously at both the transmitting and receiving machines. The two-way arrangement allows each of the two machines to be able to send and to receive message. In this serial communication, each bit

is sent, one at a time, in sequence. This method requires the use of one pair of conductors.

SPICE Simulation of a Transmission Line Model of the Ear

Researcher: Assistant Professor Louiza Sellami

This project was part of an undergraduate engineering research program sponsored by National Science Foundation at the University of Maryland. This research attempted to involve undergraduate students in research to broaden their knowledge and increase interaction between students and faculty. This project introduced the ideas of modeling of physical systems to Ms S. Pal, a senior student in Electrical Engineering. She was given a model of the ear, and instructed to write a SPICE program to simulate the electrical equivalent circuit, compare the results with experimental data, and propose hardware implementations with active devices rather than the traditional passive implementation. The analysis part include deriving the equations for the circuit consisting of 16 different cells, evaluating the values of the components for each cell using the derived equations and some experimental data, writing a SPICE program, and obtaining the response of the circuit for a set of impulses. The results showed similarities with the responses obtained with human ears, but the nonlinear effects were absent from the responses. This is because these nonlinearities were not introduced into the model itself. A modified hardware implementation using operational amplifiers to substitute for the large inductors was proposed, but a hardware realization was not implemented.

Cochlea modeling has been the subject of many studies for decades and several models exist in the literature, each one describing one or few particular functional aspects of the cochlea. However, most of these models are not directly appropriate for Kemp echo phenomenon since the latter is based on the incident and reflected pressure waves in the cochlea. Hence, a treatment in terms of scattering variables is the most relevant. Kemp echoes are acoustical signals emitted by the ear as a result of acoustic stimulation. Because there are significant differences in the Kemp echoes for normal versus certain types of damaged ears, it is felt that Kemp echoes can be used to easily characterize some types of damages to the inner ear. Furthermore, these emissions can be a reliable technique for demonstrating objectively the presence of normal activity in the cochlea, detecting changes in its functioning, as well as detecting hearing loss of noncochlear origin since, in this case, the echoes remain normal. In light of these experimental findings, a cochlea model was developed that is able to regenerate Kemp echoes. The structure of the model is such that the geometrical and mechanical properties of the cochlea are embedded in the lattices composing the model, thus allowing a systematic extraction of these characteristics.

Synthesis of ARMA Filters by Real Lossless Digital Lattices

Researcher: Assistant Professor Louiza Sellami

A new method is presented to obtain real degree-one or degree-two transfer scattering matrices of two-port lossless lattice filters through the use of complex Richard's function extractions for the minimum degree cascade synthesis of real, stable, single-input, single-output ARMA (n,m) filters from the transfer function or the input reflection coefficient . The method relies on a four-step Richard's function extraction where two steps are used for reducing the degree of the transfer function

and two for obtaining real lattices. We treat the cases where the zeros of transmission are inside and outside the unit circle but not on the unit circle. The realization is minimum, the number of lattice sections being dictated by the degree of the transfer function, and the degree two sections have real coefficients, something that cannot be obtained by simply cascading two degree-one complex sections.

Research Course Projects

Autonomous Aerial Vehicle Project

Researchers: Assistant Professor W. I. Clement, Assistant Professor B. Butka, Ensign John Tan, USN, Ensign Christopher
E. Novak, USN, Midshipman 2/C David J. Faehnle, USN, Midshipman 1/C Michael C. Lapaglia, USN,
Midshipman 2/C Richard C. Val, USN, Midshipman 1/C C.. D. Brooks Newsome, USN,
Midshipman 2/C Matthew Kawas, USN and EE 313 class members
Adviser: Lieutenent Commander D.V.P. Thoreson, CAF

This an academy sanctioned, Alumni Association and AAI Corporate sponsored entry to the annual Aerial Robotics Competition. This annual competition is conducted by the Association for Unmanned Vehicle Systems and held every summer at Georgia Institute of Technology. The object of the competition is to individually transfer six metallic disks approximately a distance of 60 feet via an autonomous air vehicle. This project offers an excellent opportunity to integrate current Academy research and interests with many sponsored midshipman sub-projects.

Reconstruction of a Periodic Time - Domain Signal "Buried" in Gaussian Noise

Researcher: Midshipman 1/C Stefan T. Sidahmed, USN
Adviser: Professor Antal A. Sarkady

In passive Sonar signal processing, quasi-periodic acoustical time series data (produced by a target) is often found "buried" in additive Gaussian ocean background noise. The object of the signal processing is to detect and characterize the target, when it is far away from the receiver (or the signal to noise ratio is very low). This task is most often accomplished by computing an averaged power spectral estimate of the noisy signal. Power spectral analysis does a reasonably good job of target detection but fares poorly in target characterization because the phase information is ignored in the spectral computations.

In this project, a new approach is taken to improve target characterization. From the spectral analysis a seed value for the period of the target signal is obtained. The original digital noisy time signal is resampled (using up/down sampling rate conversions) with such a rate that precisely an integer (typically 512) number of time samples are obtained on each cycle of the quasi-periodic target signal. These noisy cycles are synchronously averaged in the time domain (periodically folded) and an estimate for one period of the target signal is computed. The resampling and synchronous averaging algorithm is repeated recursively for many period values (about the initial seed value) until the average power in the reconstructed target signal is maximized. The residual noise power in the reconstructed target signal is inversely proportional to the number of target cycles averaged. This procedure was tested with laboratory type signals and found to have an excellent performance at signal to noise voltage ratios as low as -40dB.

Publications

KORZENIOWSKI, Kelly A., Assistant Professor, co-author, "Robotic 3-D Dual-Drive Force/Velocity Control for Tactile Sensing and Object Recognition," *Proceedings SPICE Sensor Fusion VI*, Vol. 2059, (September 1993), 334-345.

This work describes the coordination of external sensors in a robotic data collection and object recognition system. The main sensing capabilities chosen for this system are machine vision and tactile force sensing. Each sensing technique has its relative advantages and disadvantages. Therefore, the solution is to combine and coordinate

sensing techniques to take advantage of relative strengths and to compensate for weaknesses depending on the work environment and the task requirements.

Many applications of tactile sensing for data collection concentrate on driving the position of the robot by machine vision in order to collect discrete data points on the surface of an object. The work presented here differs in the respect that the dual-drive controller allows the robot to stay in contact with a surface and in general the result is that more data points can be collected in a shorter period of time. This paper shows that tactile force sensing can be used to control the robot and could be the main data collection method. Machine vision is better suited for use as a secondary data collection method that supplements tactile surface tracking by providing information about the bounding outline, and an estimate for the surface normal and thus the approach vector for surface contact points at the beginning of each tracking path.

KORZENIOWSKI, Kelly A., Assistant Professor, co-author, "Tactile Sensing with a Dual-Drive Controller for Robotic 3-D Object Recognition," 1994 NSF Design and Manufacturing Grantees Conference, (January 1994), 711-712.

Most robotic systems used today rely heavily on prior knowledge of the location of specific objects in the work space. Uncertainty occurs in these "fixed" manufacturing workspaces, where over time, the precision about the knowledge of the location of objects degrades. Therefore, the entire system must be reprogrammed when adjustments are made. A robot that is able to adapt to changes automatically, must be able to sense its surroundings and identify objects that are encountered. A robot that is equipped with force sensing capabilities can be given the task of exploring its environment.

This paper presents the results of a robotic data collection and object recognition experiment. The robot moves on a search path through its work space. No prior knowledge is assumed about the objects in the work space. When an object is encountered the 3-D dual-drive force/velocity controller makes it possible for the robot to track the surface and collect position information that is used to identify the object.

KORZENIOWSKI, Kelly A., Assistant Professor, co-author, "Reconfigurable 3-D Force/Velocity Robotic Control for Surface Data Collection and Object Recognition," *Brown University Laboratory for Engineering Man/Machine Systems Technical Report,* (May 1994), LEMS-133.

The purpose of this research is to employ multiple control laws to enable a robot to move through a constrained environment. The tracking algorithm that coordinates the actions of the robot, dynamically modifies the control laws according to feedback from external sensors and the requirements of the proposed task.

These controllers along with the tracking algorithm are implemented and tested using an IBM 7565 Cartesian robot equipped with strain gauges on the end effector. Experimental results are presented to show that the robot is able to track any arbitrary path on a complex 3-D object. The data collected is then used in an object recognition experiment to show that the data collected by the robot is useful for identifying and distinguishing between objects in the work space.

KORZENIOWSKI, Kelly A., Assistant Professor, co-author, "3-D Dual-Drive Control for Object Recognition," Proceedings of the American Control Conference, Vol. 2, (June 1994), 1396-1400.

This work describes the development and testing of a 3-D dual-drive surface tracking controller that enables a robot to track along any specified path on the surface of an object. The dual-drive controller computes the normal and tangent vectors relative to movement along the path. The result is controlled movement in 3-D on the surface of an object. This continuous contact tracking method makes it possible for dense data sets to be collected in a short period of time.

It is assumed that the tracking path is generated by an external Recognizer in such a way that the data points collected by tactile sensing along the path will maximize the probability of correctly identifying the object. This tactile data collection method is referred to as "object-dependent" sensing because the location of the sensing path is driven by comparisons made by the Recognizer to a model data base. The application for such a data collection system is object recognition tasks in environmental exploration and manipulation.

LIM, Tian S., Professor, "Fully Asynchronous Microcomputer Interface serves in a Pinch," *Institute of Electrical and Electronic Engineers (IEEE) Circuits and Systems Magazine,* (January 1994), Vol. 10, No. 1, 29-31.

This paper describes an implementation of the full asynchronous interface between two microcomputers. It details the design and test of a two-way, one line message display arrangement between two machines. The arrangement allows the user to send a message from transmitting machine to the receiving machine. The

message appears simultaneously at the screens of both the transmitting and receiving machines. The two-way arrangement allows each of the two machines to be able to send and to receive message. Eight data lines are connected between the input and output ports of the two microcomputers.

LIM, Tian S., Professor, "Asynchronous Serial Communication Between Two Microcomputers," 1993 American Society for Engineering Education (SEE) Annual Conference Proceedings, (June 1993) 676-680.

This paper describes an implementation of the full asynchronous serial interface between two microcomputers. It details the design and test of a two-way, one line message display arrangement between two machines. The arrangement allows the user to send a message from the transmitting machine to the receiving machine and the message will appear simultaneously at both the transmitting and receiving machines. The two-way arrangement allows each of the two machines to be able to send and to receive message. In this serial communication, each bit is sent, one at a time, in sequence. This method requires the use of one pair of conductors.

SELLAMI, Louiza, Assistant Professor, co-author, "A Digital Model for Cochlea Characterization," Proceedings of the 5th International Conference on Biomedical Engineering, (September 1994).

For decades, cochlea modeling has been the subject of many studies. Several models exist in the literature, each one describing one or few particular functional aspects of the cochlea. However, most of these models are not directly appropriate for Kemp echo phenomenon since the latter is based on the incident and reflected pressure waves in the cochlea. Hence, a treatment in terms of scattering variables is the most relevant. Kemp echoes are acoustical signals emitted by the ear as a result of acoustic stimulation. Because there are significant differences in the Kemp echoes for normal versus certain types of damaged ears, it is felt that Kemp echoes can be used to easily characterize some types of damages to the inner ear. Furthermore, these emissions can be a reliable technique for demonstrating objectively the presence of normal activity in the cochlea, detecting changes in its functioning, as well as detecting hearing loss of noncochlear origin since, in this case, the echoes remain normal. In light of these experimental findings, we developed a cochlea model that is able to regenerate Kemp echoes. The structure of the model is such that the geometrical and mechanical properties of the cochlea are embedded in the lattices composing the model, thus allowing a systematic extraction of these characteristics.

Presentations

BRUCE, Ralph W., Assistant Professor, " Materials Processing Using Energy Inputs at Microwave Frequencies," Sigma Xi Lecture , USNA, Annapolis, MD, 23 March, 1994 .

BUTKA, B. K., Assistant Professor, "A Simulation Study & Comparison of Cycloconverter Algorithms," Summer Computer Simulation Conference, Boston, MA, 20 July 1993.

BUTKA, B. K., Assistant Professor, "Incorporating Simulation in a First Course in Linear Circuits and Systems," IASTED International Conference on Modeling and Simulation, Pittsburgh, PA, 2 May 1994.

HODGES, Gary L., Master Instructor, and MADEKA, Frank C., Master Instructor, "The Development and Performance of the Amphibian Hybrid Electric Vehicle," SAE International Congress, Detroit, MI, 28 February 1994.

HODGES, Gary L., Master Instructor, and MADEKA, Frank C., Master Instructor, "The Selection of Lead-Acid Batteries for Use in Hybrid Electric Vehicles," SAE International Congress, Detroit, MI, 28 February 1994

KORZENIOWSKI, Kelly A., Assistant Professor, "Robotic 3-D Dual-Drive Force/Velocity Control for Tactile Sensing and Object Recognition," SPICE Conference on Sensor Fusion IV, Boston, Massachusetts, 7 September 1993.

KORZENIOWSKI, Kelly A., Assistant Professor, "A Robotic 3-D Object Tracking Controller," NAWC Warminster, PA, 4 November 1993.

KORZENIOWSKI, Kelly A., Assistant Professor, "Tactile Sensing with a Dual-Drive Force/Velocity Controller for Robotic 3-D Object Recognition," Sigma Xi Society Meeting, 16 February 1994.

LIM, Tian S., Professor, "Asynchronous Serial Communication Between Two Microcomputers," 1993 American Society for Engineering Education(SEE), Annual Conference, June 1993.

SELLAMI, Louiza, Assistant Professor, and Newcomb, Robert W., "A Digital Model for Cochlea Characterization," V International Conference on Biomedical Engineering, Santiago, Spain, September 1994.

Mechanical Engineering

Professor Russell A. Smith,
Chair

Research and scholarly activity in the Mechanical Engineering Department spanned the broad interests of practicing engineers. Work was active in thermodynamic modelling, fluid mechanics, solid mechanics and materials engineering. Projects in thermodynamics included optimization studies and engine cycle diagnostics. The studies in fluid mechanics encompassed turbulence, three-dimensional boundary layers, bearing hydrodynamics, modelling centrifugal pump flow, and external flow field analysis. The solid mechanics work included an extensive fracture mechanics program, as well as both experimental and computer simulation studies of composite materials and mechanical vibrations. Materials engineering spanned work in corrosion and environmental effects on composite materials. A substantial engineering demonstration project in hybrid-electric vehicle technology was completed and entered in a national competition.

Support was obtained from external sources including the Office of Naval Research, the Naval Surface Warfare Center, the Nuclear Regulatory Commission, and the Naval Academy Research Council. Also, numerous projects were sustained by faculty without external support. The projects supported improved laboratory teaching for midshipmen as well as defining new opportunities for future support of faculty research. Several midshipmen projects under the guidance of faculty were completed this year as well as one high school mentorship project.

The quality of scholarly work performed by the faculty and midshipmen of the department is reflected in the numerous papers and presentations made at national and international conferences.

Sponsored Research

Biomechanical Analysis of Different Segmental Fixation on Spondylolysis

Researcher: Assistant Professor Oscar Barton Jr.
and David W. Miller
Sponsor: Walter Reed Army Medical Center

The motivation of this work is to compare which of three different methods of segmental fixation used to treat spondylolysis provides the greatest amount of stability across the pars interarticularis defect.

Structural Analysis

Researchers: Assistant Professor Oscar Barton Jr
and Assistant Professor R. Raouf
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

This project pursues structural analysis of fatigue test facilities through a finite element study of the structural response of a steel frame for possible use in evaluating full-length compositeshafts. Some goals of this research are to derive a closed-form expression for the stress distribution in pin joints in composite plates and to

develop a computer code that allows extrapolation of   limited fatigue-test data.

Development of Diagnostic Methodology for Engine Cycle Analysis

Researcher: Assistant Professor Gregory W. Davis
Sponsor: Naval Academy Research Council (ONR)

Although the emphasis in engine research has shifted toward the development of engine simulations, actual engine testing is still the predominant component in engine research and development. Thus, diagnostic models which analyze engine data to provide insight into the underlying thermodynamic processes are still important to the engine researcher.

Earlier research, in which the investigator has been involved, has resulted in the development of diagnostic models that provide spark-ignited engine cycle information by analyzing a limited number of common engine test parameters. These models provide estimation of mass-fraction burned with respect to engine crank angle, total in-cylinder residual fraction, and average cylinder gas temperature. Because of the simplicity of the diagnostic methodology, it has potential for use in on-line engine diagnostic and control systems.

The proposed research initiative will continue to develop the existing diagnostic methodology through verification with established computer engine simulations and experimental data. As new models are developed, they will be tested against the output of a comprehensive engine simulation and then using actual engine data.

Naval Academy Research Council funding for 1992 helped to provide the extensive upgrading engine test facilities required to provide the ability to gather experimental data for use in the verification of these models. This laboratory refurbishment is nearing completion. Further work includes the development of a system to gather cylinder gas samples from an operating engine. These samples will then be analyzed to provide accurate determinations of the cylinder gas composition prior to the combustion process. This data is required for verification of the total in-cylinder dilution diagnostic model. Due to the high rate of data acquisition required, a high speed data acquisition board has been procured to gather this data. System equipment also includes data acquisition and control software and a high speed sampling valve. Further, I am currently using the computer from my office for this purpose but this is obviously not a good permanent solution as the computer must be disassembled and moved to the engine laboratory to conduct the testing. It is anticipated that this process will lead to the formulation of additional models for use in estimating other engine combustion parameters.

Shipboard Applications of Catox Systems

Researcher: Associate Professor Elliott E. Dodson
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The Chief of Naval Operations requires, via OPNAVINST 3400.10E, that U.S. Navy Surface ships and overseas bases be provided with chemical, biological, and radiological (CBR) defense capabilities that enhance sustained warfighting capabilities in a CBR threat environment. These capabilities include collective protection systems (CPS) to remove toxic agents from ventilation air supplies to operational spaces.

CPS currently being implemented aboard ships and in selected overseas base shelters use high efficiency particulate air (HEPA) and activated carbon absorption

filters to provide protection against classical chemical and biological (CB) warfare agents. However, Naval Technical Information Center (NTIC) document #004-90, February 1990, assesses the chemical and biological warfare threat to U.S. Naval Forces, including agents which can or may defeat the current filtration system. CATOX technology possesses the greatest potential for meeting as well as exceeding the operational requirements of the existing carbon/HEPA filtration system.

An Experimental Investigation of a Line Array of Charges Descending and Being Towed

Researcher: Professor Robert A. Granger
Sponsor: Naval Surface Warfare Center, CSS, Panama City, FL

The behavior of a line array of fixed charges has been investigated rather extensively. There have been tests of assorted types and descriptions that involve investigating the physical dynamic structure of towing cables interacting with the external hydrodynamic forces from ocean currents and towing configurations with the purpose being to ensure a proper design that meets the objectives of the particular study. The present experimental investigation is composed of two parts. The first part is a study of the behavior of a line array of charges (canisters) while descending from rest at a predetermined depth below the free-surface at various sea states to the floor. The initial configuration of the line array is horizontal and stationary with the charges equally spaced apart. The charges are circular cylinders possessing a specific effective weight. The charges are rigidly attached to a continuous flexible nylon rope with free ends. The purpose of the tests is to determine the physical location of each charge in a vertical plane relative to its initial horizontal configuration as it descends to the tow tank floor. It is interesting to note that this free-descent problem is not treated theoretically in the vast literature. Thus, a theoretical investigation was conducted, and the results of the mathematical model are presented in Appendix A. Two theoretical models are treated. This is because one may solve the identical problem using either the concept of force or the concept of energy.

A Hot Body with Suction in a Magnetic Field

Researcher: Midshipman 1/C David Walter Fink, USN
Adviser: Professor R. A. Granger
Sponsor: Trident Scholar Program

This project will analyze incompressible flow of a Newtonian Fluid past a vertical, flat plate with thermal and magnetic stresses. This analysis will include deriving the equations governing the fluid velocity and the temperature distribution. The equations governing fluid velocity will be derived from a force balance approach for a differentially small parcel of fluid.

The equations governing temperature will be derived from the principle of conservation of energy. Energy and temperature are closely related. In fact, in an incompressible fluid temperature is a direct measurement of internal energy.

These equations will then be programmed to provide a computer simulation for predicted velocity and temperature fields for various parameters. These simulations will tell us whether or not it is possible to "shape" velocity and temperature distributions using magnetic fields. Possible applications include heat exchanges and any transfer process using fluid flow as a transport medium.

The Effect of Environment on the Mechanical Behavior of Composite Materials

Researcher: Professor Dennis F. Hasson
Sponsor: Office of Naval Research

Future naval structural and power systems require advanced engineered materials. Composites are candidate materials which could fulfill these requirements. For ships and aircraft structural applications the composite usually employs a polymer matrix, while for higher temperatures a glass or glass-ceramic matrix. These composite systems are designated PMC and CMC, respectively. While ambient condition mechanical property information is available, environmental effects on the performance of composites have not been extensively investigated. An example for CMC's is the effect of a soak in a high temperature oxidizing atmosphere on impact toughness; and for PMC's the effect of freeze/thaw cycles on the strength of

a composite with a high water content.

Evaluation of Elastic-Plastic Fracture Mechanics of LWR Alloys

Researcher: Professor James A. Joyce
Sponsor: U. S. Nuclear Regulatory Commission

This project coordinates work at University of Illinois, Brain University and Texas A & M in the area of constraint effects on elastic plastic fracture. Present funding is $730,000 via NSWC Annapolis. The effort is directed to understanding the corrections needed to apply standard laboratory data in real nuclear reactor applications. Experimental testing and numerical analysis is combined to transfer fracture roughness results from simple work parameters to complex structural applications and test where available. This work has been funded since 1990 and progress has been exceptional. Funding has grown accordingly from $150,000 to $730,000. Continued rapid progress is expected as experiments and analysis converge.

Computational and Experimental Investigation of the Pressures and Velocities in a Single Volute Centrifugal Pump

Researchers: Assistant Professor Steven M. Miner, and R. D. Flack, W. de Ojeda
Sponsors: Naval Academy Research Council (ONR) and Naval Surface Warfare Center, Annapolis, MD

Static pressure tap measurements were recorded around the impeller and along the casing wall of a single volute centrifugal pump with a specific speed of 0.60. Laser velocimetry measurements at the impeller periphery complemented the pressure measurements. By integration of the circumferential pressure and momentum flux variations, static forces were found. A finite element potential flow method was also used to predict the pressures, velocities, and forces. Flow rates ranged from 20% to 105% of design. At near design conditions the experimental pressures were uniform to within 11% at the impeller exit; however, at low flow rates the highest pressures were skewed toward the discharge with a 36% circumferential variation. Experimentally, the contribution by the momentum fluxes to the radial thrust on the impeller was negligible, only 0.09 N at design. The radial thrust due to pressures ranged from 5.6 N to 33.0 N at 105% and 20% design flow, respectively. Theoretically, results are presented for 100% and 75% of design flow, and comparisons between , measured and predicted results are presented for pressures velocities and forces. At design flow the impeller exit pressure were uniform to within 7%, at 75% of design flow the variation increased to 19%. The predicted radial thrust was 2.48 N at design flow, and 8.66 N at 75% flow.

Potential Flow Analysis ofCentrifugal Pumps

Researchers: Assistant Professor Steven M. Miner, and R. D. Flack, W. de Ojeda
Sponsor: Ingersall Raud

This is an ongoing project to develop an analysis technique for studying the flow field within volute or diffuser type centrifugal pumps. Two-dimensional potential flow is used to model the potential field within the impeller and the volute or diffuser. The rotating and stationary components are modeled together to capture the interaction that takes place between these components. The potential field results are used to determine the velocity and pressure fields. These fields are then used to calculate momentum and pressure unbalance forces on the impeller.

The previous years efforts have focused on performing quasi-static analyses, the current effort includes the transient effects in the analysis. These transient effects are included by adding the transient term to Bernoulli's equation. This transient term affects the pressure field, which in turn has effects on the pressure unbalance force. At this time the transient term has been incorporated, and analysis of a volute type centrifugal pump is underway. After completion of the volute pump, a diffuser pump analysis will be performed.

Potential Flow Analysis of Centrifugal Pumps

Researcher: Assistant Professor Steven Miner
Sponsors: Naval Academy Research Council and Naval Surface Weapons Center, Annapolis, Maryland

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Intelligent Spray Forming

Researcher: Assistant Professor Angela L. Moran
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The spray forming process is ideally suited to the application of intelligent control methods. The process has significant metallurgical and economic benefits, but requires sophisticated control technology to achieve the level of reliability and reproducibility required for widespread commercialization. Process models are a

precursor for such control and are under development. Critical process parameters can be sensed and controlled via a fuzzy logic controller that identifies and implements parametric actions based on process conditions. This research highlights intelligent spray forming studies at Drexel University and the Naval Surface Warfare Center.

Spray Forming and Near-Net-Shape Manufacturing

Researcher: Assistant Professor Angela Moran
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Spray forming is a single step gas atomization/deposition process which yields ferrous and non-ferrous near final shape, fully dense preforms. In the Osprey spray forming process, molten metal is rapidly atomized to form a fine spray of particles that are deposited onto a collector or mandrel at rates up to 400 pounds per minute. The microstructure of the as deposited preform is fine-grained and uniform with minimum microporosity. Spray forming has proven to be a viable and cost effective alternative to conventional metalworking technology for the production of material preforms with properties surpassing those of their cast and wrought counterparts. Current Navy programs are aimed at optimization of the process, certification of the spray formed products and industrialization of the technology. This includes the development of real-time sensors interfaced with an automated fuzzy logic controller and expanded motion control system to monitor the critical process conditions

and to modify parameters during the process. Robust sensors and controls have been combined with a five axis manipulator and integrated into the Navy spray forming facility at NSWC. The system has the capability to manufacture low cost, improved performance, non-symmetric components currently producible only by casting or forging. In another program, commercially available spray formed piping from foreign sources is currently being evaluated and certified for near term use in the Fleet. This effort will determine if the process is certifiable as a viable low cost alternative for conventional piping manufacturing of Alloy 625 piping for Naval applications. Alloy 625 piping has been produced via the Osprey spray forming process in specified diameters ranging from 4 inch diameter up to 14 inch NPS diameter and is being tested for product specification compliance. Industrialization efforts are under way to establish domestic capabilities as there are

no commercial facilities in the United States to date. Results from the intelligent processing program will be combined with other Navy developments in optimization of the spray forming process and integrated into a large pilot plant facility. Navy applications including torpedo tubes, shaft seals and sleeves, piping and bearings are being addressed. Dr. Moran was responsible for the development of these programs at NSWC and now provides technical support for these efforts.

Investigation of the Crevice Corrosion of Alloy 625 in Seawater

Researchers: Associate Professor Patrick J. Moran
Ensign Mark C. Reyes, USN
Engineering Technician John Hein
Sponsor: Naval Academy Research Council (ONR)

Alloy 625 is a NiCrMoFe alloy and is the main piping material in the new SSN21s. Alloy 625 has excellent mechanical & welding properties and, with the exception of crevice corrosion, excellent corrosion properties. It has been found to be susceptible to crevice corrosion in seawater service. The Naval Surface Warfare Center in Annapolis, MD is the main Navy laboratory evaluating the problem and has provided the samples. Crevice corrosion occurs in acidic environments due to hydrolysis cations of the metal concentrate in the crevice. One of the difficulties in modeling crevice corrosion processes or in proposing solutions is that it is not known in what proportion the Ni, Cr, Mo, and Fe dissolve from the Alloy 625 surface in the crevice environment. These elements control the extent of acidity. In this research, project specimens which have experienced crevice corrosion are being carefully analyzed with scanning electron microscopy and x-ray microanalysis to determine the concentration of the Ni, Cr, Mo, and Fe remaining at the attacked sites. Specimens with varying amounts of crevice corrosion attack were obtained from NSWC-Annapolis. Comparison of the concentrations of the attacked regions with the normal alloy concentration is allowing determination of exactly what elements dissolved into the crevice region and promoted the aggressive environment. Such information will lead to better modeling of the crevice corrosion process for Alloy 625 which will allow the severity of attack in various crevice geometries to be predicted accurately and will assist efforts to develop control measures and alternative materials. Upon completion of this analysis, the author plans to approach a commercial alloy producer to produce test heats of alloys with similar concentrations of alloy 625 but with modifications intended to reduce the crevice corrosion. Evaluation of the modified alloys will be conducted in laboratory tests at the U.S. Naval Academy.

Influence of Heat Treatment on the Corrosion Properties of Stainless Aluminum Alloys

Researchers: Associate Professor Patrick J. Moran
Dr. Christopher C. Streinz
Engineering Technician John Hein
Sponsor: Office of Naval Research

Aluminum alloys are used extensively in the U. S. Navy and range from light weight, high strength aircraft components to super structures on ships. Corrosion problems are commonly encountered with these materials. The elements typically added to aluminum to improve mechanical properties such as copper, magnesium, and zinc, generally do not increase the corrosion resistance. However, a new class of aluminum alloys with exceptional corrosion resistance, referred to as "stainless aluminum alloys", have been developed by the Naval Research Laboratory. These materials involve alloying elements which specifically increase the aluminum alloy's ability to resist corrosion; such as tantalum, tungsten, silicon, molybdenum, and chromium. These elements help to form a more protective passive film on the aluminum surface which dramatically improves the corrosion resistance. Unfortunately, these elements have limited solubility in the aluminum crystal

structure and if they are processed by conventional means or if they are heated after processing additional phases develop and the alloying element will no longer be in the aluminum matrix and will therefore not develop the enhanced corrosion resistance. Therefore, these materials must be processed by fast solidification methods which trap the alloying element in the parent aluminum phase. This project is evaluating two rapid solidification

processing methods, spray forming and sputter deposition, for the production of these alloys. It is also evaluating the influence of subsequent heat treatment on their corrosion properties. Aluminum-tungsten and aluminummolybdenum alloys are being investigated because these two alloys have shown good corrosion resistance and one resistance to development of second phases during heat treatment.

Influence of Implanted Nitrogen on the Corrosion Properties of Stainless Steel Alloys

Researchers: Associate Professor Patrick J. Moran, Dr. Christopher C. Streinz
and Engineering Technician John Hein
Sponsor: Office of Naval Research Postdoctoral Program

Nitrogen additions to stainless steel improve the corrosion resistance of stainless steel in chloride environments. A novel process for implanting nitrogen in stainless steel has been developed at National Institute of Standards and Technolgy, who provided the samples. The process achieves higher concentrations of nitrogen in the stainless steel than are possible with traditional processing. The corrosion properties of these new

materials are being evaluated at USNA and compared to conventional stainless steels. The integrity of the passive film, the resistance of pitting corrosion and crevice corrosion are being evaluated. Results to date indicate that the corrosion properties of the novel stainless steels are superior to conventional stainless steels of the same composition (ignoring the nitrogen added).

The Effects of Prior Pitting Damage on Repassivation Potential

Researcher: Midshipman 1/C Jason R. Frei, USN
Adviser: Associate Professor Patrick J. Moran
Engineering Technician John Hein
Sponsor: Trident Scholar Program

There has been considerable controversy over the relationship between repassivation potential and pit size in passive metals such as aluminum and stainless steel. Understanding this behavior is very important when determining the appropriate level of cathodic protection for previously damaged systems. The repassivation-size relationship was explored in this experiment using a procedure known as the Scanning Reference Electrode Technique (SRET). Steel and aluminum samples were immersed in a 3.5 wt% NaCl solution simulating sea water. The samples were then polarized above the pitting potential and pitting activity was measured on a pit by pit basis with the SRET. The potential was then lowered in

0.1 V steps until all pits repassivated. No data was obtained for the aluminum due to its pitting characteristics, however, data was collected and analyzed on an individual pit basis for the 316 stainless steel. The pits analyzed varied in diameter from 0.31 mm to 1.63 mm, and showed repassivation potentials between 0.6 V and 0.5 V (vs. SCE). The data showed a decrease in repassivation potential of 0.093 V for an increase in diameter of 1 mm. This demonstrates that when cathodically protecting a damaged system, the level of protection must be held below the repassivation potential of the largest pit.

Determination of the Dynamic Properties of Composite Pipes

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, MD

This report details the measurement of the complex elastic modulus of composite pipe sections when subject to axial vibration. Experimental frequency response function measurements of accelerance (acceleration per unit force) are compared to those derived from a complex theoretical model. Parameters in the model were varied until a good curve fit was obtained. Levels of damping are compared to those obtained with a modal analysis.

Classic vibration theory is used to determine an undamped theoretical model including both discrete and continuous elements. This is extended to include hysteretic damping by making the stiffness term complex. The full expansion of the equations is extensive and is not necessary for a good curve fit. Therefore, an intermediate simplification for wave speed is made.

The test method and theory were checked against a steel pipe. This was intended to verify the theory and test arrangement, but instead highlighted a problem caused by a similarity in wave speeds in different parts of the test structure. The test was also applied to 3 different composite cylinders, with one being tested both empty and with a dry sand filling.

Vibration Analysis of Fire Protection Panels

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Eric Greene Associates, Annapolis, Maryland

This report details the vibration measurement of fire protection panels. One plate was analyzed both before and after fire testing, and the remaining three were only analyzed after fire testing. The results obtained from this analysis were natural frequencies, mode shapes at resonance and modal damping. The plate analyzed before and after fire testing was a triple skin box section. The modal comparison showed that as a result of fire testing, all natural frequencies increased, and all viscous damping ratios decreased.

The post fire testing analysis of the other plates showed that local structural weakening could be identified through irregularities in mode shapes. Data from before the fire testing was not available, and therefore no comparison of mode shapes and modal damping could be made.

Investigation into the Dynamic Behavior of an Aeroflex Wire Wound Vibration Isolation Mount

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderok, Maryland

This report details the results of an investigation into the dynamic properties of a shock and vibration isolation mount manufactured by Aeroflex. The mount is designed for marine applications, and consists of approximately 1 inch stainless steel rope, coiled into 8 loops, each approximately 5 inches in diameter. The rope is constrained into this design by top and bottom metal bars, which also serve as load and mounting platforms.

The tests were designed to determine the transmissibility of the mount. The mount was nonlinear. Damping and resonant frequencies were estimated as a function of excitation level. The tests reported are the first of a series and were conducted with the mount suspended on rubber bungee cords. The results include a modal analysis used to identify the important frequencies and transmissibility across the mount.

The Effects of Preload and Contamination on the Performance of Wire Wound Vibration Isolation Mounts

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, MD

This report details an ongoing investigation into the dynamic properties of a wire wound shock and vibration isolation mount manufactured by Aeroflex. Earlier work, with the mount suspended on rubber bungee cords, showed it was nonlinear in terms of both stiffness and damping. This report includes details of transmissibility and mechanical impedance measurements of the mount under various load conditions. In addition, it reports the effect of oil and dirt contamination on the performance of the mount.

Opportunity was taken to compare transmissibility estimation from the direct ratio of force measurements, to that obtained from a post calculation of receptance data.

Noise Reduction of Underwater Cylindrical Structures

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

This report includes the full script of a presentation on noise reduction of underwater cylindrical structures. The presentation details the work undertaken during previous years in a collaborative effort with NSWC, USNA and other universities. Reduced size monochrome copies of the viewgraphs are included as an Annex.

An Investigation into the performance of a Rubber and Composite Vibration Isolation Mount Subject to a Shock Test

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

This report investigates the performance of a vibration isolation mount when subjected to a shock test. For the test the vibration mount has a load secured to it, and the combination is fastened to a shock table. The test comprises of an initial rise of the shock table, which is then abruptly snubbed.

This report analyzes the initial rise of the shock table with the mount and load on it. Inspection of load v. deflection data for the mount shows that for moderate amplitudes it can be considered linear. Therefore this report assumes linearity, and applies a modal decomposition, time solution and modal superposition.

A numerical example, using typical values, shows that even during the initial rise of the shock table, the deformation of the mount is such that linearity cannot be assumed. However, the concepts derived in this report are valid for lesser shocks or more linear mounts, and warrant further investigation.

Transmissibility of an Aeroflex Cable Mount

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

The static and dynamic properties of an Aeroflex cable mount, part number C4498-88-1A, were measured at various loads to determine its vibration isolation characteristics. Mount resonant frequency was calculated from dynamic stiffness measurements using the non-resonant method. Transmissibility measurements were conducted using an electromagnetic shaker system. At the in-service load of 170 lbs, these results showed reduced isolation effectiveness due to standing waves in the mount over the frequency range 1500-2500 Hz. It was shown that the mount was highly nonlinear in terms of stiffness and damping. The results reported here include a modal analysis, used to identify the important frequencies, and transmissibilities across the mount.

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No significant changes were observed in the mount's performance when it was contaminated with TEP2 190 hydraulic oil and tobacco ash.

Modal Testing of Composite Cylinders

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

In the manufacturing of composite structures, the material and structure are fabricated simultaneously. As such, specific moduli, strength, and physical characteristics can be readily incorporated into the structure without the necessity of secondary manufacturing steps. One fabrication method amenable to structures with axisymmetric configurations is filament winding. This paper presents recent efforts to increase the damping of one type of axisymmetric structure, i.e cylinders. The design, fabrication and modal testing of the composite cylindrical sections with varying structural cross sections are presented. These sections included monolithic sections, cylinders with internal damping treatments, and several variations of a double hollow core configuration. The cylinders tested had internal diameters of 15.9 and 22.9 cm (6.25 and 9 in). with lengths of 30.5 and 54.6 cm (12 and 21.5 in), respectively. Frequency response data for the "freely suspended" cylinders were obtained by impact testing. This paper reports the results of a vibration analysis of these data using a commercial modal analysis package. The results include natural frequencies, mode shapes and levels of damping, which are compared with those of a baseline aluminum cylinder. All of the composite cylinders tested had loss factors greater than the baseline aluminum, with an increase between 34% to 560%.

Graphite/Polyurethane Flexible Composites Mechanical Vibration Damping Properties

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

Structures fabricated with advanced composite materials, such as graphite fibers in thermoset or thermoplastic resins, typically possess high stiffness. The material is elastic to failure, which occurs at strain levels which are relatively low, on the order of 2 to 5 %, depending on fiber orientations. There are numerous naval applications in which systems are subjected to significantly large deformations due to the global deformation of the ship hull. To allow the subsystems to function while being subjected to these large global deformations, flexible couplings are often incorporated. These couplings must transfer in-plane loads and torque while allowing for dissimilar motion of each component. This paper describes such a structural configuration which is both flexible and structurally adequate to support significant mechanical loads. This flexible composite systems consists of a braided graphite fiber preform infiltrated with a polyurethane, Adiprene, which has a modulus of 1100 psi and a strain to failure of 300%. This composite system possesses adequate structural characteristics of strength and stiffness, the capability to undergo large global deformations, while simultaneously dissipating significant levels of mechanical vibration energy. This paper discusses the fabrication and design of the flexible composite material, the mechanical characteristics and the damping that it provides.

Structural and Damping Characteristics of a Flexible Composite Structure

Researcher: Assistant Professor Colin Ratcliffe
Sponsor: Naval Surface Warfare Center, Carderock, Maryland

There are may applications where structural components must accommodate significantly large deformations. To allow the components to function effectively while deformed, elements such as flexible couplings may be used. These couplings must transfer in-plane forces and torques, while allowing for a large relative motion across

them. Advanced composite materials, such as graphite fibers in thermoset or thermoplastic resins, typically possess high stiffness and relatively low strains to failure in the order of 2% to 5%, depending on fiber orientations. In addition, the mechanical vibration damping of conventional monolithic forms of these structures is relatively low. Therefore, conventional composite materials may not be ideal for constructing couplings.

This paper describes a configuration which is both flexible and structurally supports engineeringly significant loads. This flexible composite system consists of a braided graphite fiber preform infiltrated with different polyurethane systems which have a modulus range of 600-1100 psi, and a strain to failure of 100%-400%. These novel composite system possess adequate structural characteristics of strength and stiffness, and the capability to undergo large global deformations, while simultaneously having higher mechanical vibration damping. This paper discusses the fabrication and design of the flexible composite coupling, its mechanical characteristics, and the damping that it provides.

Theoretical Performance of Slotted Hydrostatic Bearings

Researcher: Professor Chih Wu
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The U.S. Navy is currently seeking a low-noise bearing submarine at starting or low rotating conditions. A hydrostatic bearing has been proposed for this purpose. Some experimental modelling work have been done by DTRC-Annapolis branch. The objective of this project was to verify the experimental data and to predict the performance of the prototype. The theoretical analysis on the performance of a slotted hydrostatic bearing is performed. Finite difference method is used to carryout the numerical solution. Load and flow rate results generated by computer work station are compared with experimental test data in good agreement. The load and flow rate calculated for the small model bearings from the theoretical equations show good agreement with the experimental data.

Independent Research

MathCAD Applications in Engineering and Computer Graphics

Researcher: Professor J. Alan Adams

During the Academic Year 93-94, Dr. J. Alan Adams was an exchange professor at the Britannia Royal Naval College in Dartmouth, England. In addition to teaching duties, pedagogical research was carried out to determine the suitability and desirability of various equation solvers for use in the classroom due to its mathematical syntax and friendly user interface. Both TkSolver and MathCad proved useful for research and development. TkSolver was powerful for solving problems of intersecting surfaces where a large number of non-linear equations were solved simultaneously. MathCad was useful for surface definition where matrix methods were common.

Problems in geometric modeling were solved to illustrate the power of using a mathematical approach to problems of both descriptive and differential geometry. Geometric properties were most easily obtained using the differentiation and integration functions available in MathCAD. The matrix functions in MathCAD also made the definition of surfaces using techniques of non-uniform rational B-Splines (NURBS) attractive. Engineering applications included fast fourier transforms of signals, vibration of mechanical systems, thermodynamic processes, and fluid flow behavior.

Sensitivity Analysis in Composite Structural Mechanics

Researcher: Assistant Professor Oscar Barton Jr

Approximate closed-form solutions are sought to analyze the mechanical behavior of composite structures. In particular, the abstract eigenvalue problem associated with both buckling and vibration is studied by casting the problem in discrete form and expanding the eigenvalue about a known solution in a Maclaurin series.

Development of Hybrid electric Vehicle Technology

Researcher: Assistant Professor Gregory W. Davis

A series Hybrid Electric Vehicle(HEV) has been developed for use in the 1993 Hybrid Electric Vehicle Challenge and is scheduled to compete again in the 1994 Competition. These competitions are jointly sponsored by Ford Motor Company, Saturn Motors Corporation, the Society of Automotive Engineers, and the Department of Energy. A 5-door Ford Escort Wagon with a manual transmission was converted to a series drive hybrid electric vehicle. The propulsion system is based on a DC motor which is coupled to the existing transmission. Lead-acid batteries are used to store the electrical energy. The auxiliary power unit(APU) consists of a small gasoline engine connected to a generator. The AMPhibian is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon existing technology. Further, this vehicle has been designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle. The major performance design goals for the AMPhibian include 1) the ability to travel 64 Km as a zero emissions vehicle(ZEV) using battery power alone, 2) operating in hybrid mode, the ability to travel 320 Km while meeting the transitional low emissions vehicle(TLEV) air pollution standards, 3) achieve a time of under 15 seconds when accelerating from 0 to 70 Kph, and 4) climb a minimum of a 15% grade. To improve the performance of the hybrid electric vehicle, a simple regenerative braking system has been designed. Based upon design calculations, it is estimated that this system could provide up to approximately a twenty percent increase in electric range when the vehicle is driven in urban conditions. The design of both the vehicle, and of the regenerative braking system is presented. Additionally, actual performance results of the HEV, when tested both with and without the regenerative braking system, are reported and compared with the original gasoline powered vehicle.

Development of Finite-time Thermodynamic Analysis

Researcher: Assistant Professor Gregory W. Davis

Finite-time thermodynamic analysis can provide new insight into the theoretical of cyclic machine operation. Not only can it provide expressions for the upper bounds of efficiency and rate of desired energy delivered, but it can also provide additional insights into the design of these devices. The information provided using this technique is more conservative than that provided in the Carnot cycle analysis, and, therefore, is more useful to the design engineer. The method of investigation is purely theoretical due to the nature of the analysis. To date, several cyclic devices have been analyzed, including geothermally powered heat pumps and air conditioners, regenerative Stirling cycles, etc. Research is currently in progress involving the utilization of low-grade thermal energy, and cascade Rankine power cycles. This research is usually undertaken in collaboration with Professor C. Wu, of the Mechanical Engineering Department.

Near-Wall Similarity of Three-Dimensional Turbulent Boundary Layers

Researcher: Assistant Professor Karen A. Flack

Predictive codes for the computation of turbulent flows in complex engineering devices require substantial computing resources and time. However, if the code is to be more than a basic research tool, as well as useful to the community of engineering designers, then it must run rapidly and at a relatively low cost. For three-dimensional boundary layer problems the effort (mesh size, memory, etc.) increases, necessitating more powerful and expensive computers. The mesh size near the wall, where severe velocity and pressure gradients occur becomes extremely small. Equations that model the near-wall flow would greatly reduce computational time and cost. The current research focuses on the determination of wall functions for three-dimensional turbulent boundary layers, with the ultimate goal of possibly extending near-wall similarity relationships of two-dimensional boundary layers to three-dimensional flows. So far, the research has established a near-wall empirical equation that models a stress/strain parameter using experimental data. Currently the research is of a more analytical nature, focusing on mean-flow parameters (mean velocities, flow angles, pressure gradients) in the near-wall region for strongly three-dimensional flows.

Three-Dimensional Turbulent Boundary Layer Near-Wall Structure

Researcher: Assistant Professor Karen A. Flack

Turbulent boundary layer flow was once thought to be a chaotic mess of structures, similar to a "spaghetti bowl" of vortex filaments. However, flow visualization has shown that a turbulent boundary layer actually contains a regular pattern of coherent structures. The coherent structures of two-dimensional boundary layers have been studied intensively over the past thirty years using flow visualization and statistical measurement techniques. A better understanding of these structures has led to research concerning the control of the turbulent boundary layer in an effort to minimize surface drag. The current research focuses on the coherent structures in the near wall-region of a three-dimensional turbulent boundary layer flow, to determine the influence of cross-flow on the near-wall turbulence structure.

Water on Mars

Researcher: Professor Robert A. Granger

This book is a treatise dealing with one of the classical mysteries today: namely, is there or has there ever been any liquid water on the planet Mars? The only positive answer to this question will come with landing man on Mars. Since this may not take place for another decade, we can make certain qualified estimates using carefully controlled scientific measurements. Scientists have made spectacular evaluations in the past 15 years based on studying photographs and technical data from two important space flight missions. These scientists presented their findings at international symposiums as well as published their technical papers in refereed international scientific journals. This was after considerable scrutiny by experts in their field. Every pitfall, each assumption and premise was meticulously examined. Experimental errors, bias and appropriateness of reference datum was questioned. Many of the experimental conclusions were supported by elegant mathematical models lending further credence to their conclusions. These models also had imposed assumptions necessary to make the theory tractable and solvable. Water on Mars plays perhaps the single most important role in sustaining life. Obviously without it, man has a limited time on Mars. But if there is water, be it surface ice, subterranean liquid water, or water vapor, then man can pursue the possibility of establishing colonies on Mars.

Electromagnetic Rheology

Researchers : Professor Robert A. Granger and Brian Frykadale

This investigation showed that we could easily reduce the frictional force between moving objects that are close together by a slurry of metal particles in specific fluids.

The slurry is then subjected to a magnetic field. These are unique values of metallic concentrates to liquid and magnetic field strength for minimum friction.

Fluid Dynamics of Quantum Cosmology

Researcher: Professor Robert A. Granger

Cosmology has made considerable progress since Hubble announced his discovery of a linear-expansion law in 1929. Much of the activities in this field has occurred over the past decade and has been stimulated by, input from high energy physics. The origin and evolution of large-scale structure and the formation of galaxies remains one of the most important problems in astrophysics that is still largely unsolved. This has not deterred cosmologists, however, and much progress, at least in identifying critical aspects, has occurred. The researcher will summarize these various developments and discuss several topics. These are observational cosmology, the large-scale structure of the universe, primordial fluctuations, dark matter, statistics of Gaussian fluctuations, large-scale peculiar velocities and cosmic microwave background anisotropies. This review is aimed primarily toward the physicist who is not familiar with astrophysics, nor initiated into the more esoteric cosmology of the astronomer.

Coherent Structures in Turbulence

Researcher: Professor Robert A. Granger

Although a great number of turbulent flow configurations have to some extent been investigated and scrutinized for their content of structural organization, many questions still remain. This review will attempt to summarize a few of the more important results and issues. At the same time some open questions will be discussed.

Meanwhile, an abundance of knowledge has been collected on some free flows, in particular the mixing layer, the wake, and to a lesser extent, the turbulent far jet. All free flows undergo at least one transformation before they become self-similar and possibly unique. Thus, the mixing layer is the eventual outcome of the transformation of the boundary layer flow from the nozzle. Jets and wakes in their early stages go through intermediate mixing-layer manifestations. Also in those cases the researcher often found more than one characteristic structure.

Different structural developments appear to be related to different behaviors of the basic flow: The more complex structures, characterized by three-dimensional (Reynolds number and/or lifetime-dependent) agglomerations of hairpin, ring ,and spiral vortices, are found in those flows which are primarily fictionally unstable (wall flows). Particularly in the boundary layer, one observes a whole zoo of structures, some of which (e.g. the wall streaks) clearly violate the obviously too limiting 'classical' definition if coherent structures being exclusively 'large scale' events. Consequently, as much as these findings undoubtedly add to an understanding of turbulent processes, the concept of coherent structures forfeits some of its original meaning for a more refined picture, the larger the structural multitude becomes.

Laser Velocimetry Measurements in a Double Volute Centrifugal Pump

Researchers: Assistant Professor Steven M. Miner, and R. D. Flack, W. de Ojeda

In collaboration with the University of Virginia ROMAC Laboratory, laser velocimetry measurements were taken in a double volute/single discharge centrifugal pump (0.60 specific speed, 1583 US units) with symmetrical volute halves. Blade-to-blade radial and tangential velocity profiles at the impeller exit are presented and compared to data for a similar single volute pump. Flow rates ranged from 40% from design flow to the design

point. The blade-to-blade profiles were more uniform than for the single volute pump. Also, the average circumerential variations for the double volute pump were more symmetric than for the single volute pump. For the double volute geometry, measurements indicate that radial inward flow (recirculation) was only present for flow rates below 60% of design flow, compared to 80% of design flow for the single volute pump. Velocity data was also used to determine volute losses, slip, and momentum contributions to the impeller radial forces. Volute losses were quantified and shown to increase for flow rates below 80% of design flow and were approximately 10% of the developed head at 40% flow.

The efficiency in the double volute compared to the single volute shows decreased performance for flows above 55% of design flow. This is attributed to increased boundary layer friction; at low flow rates increased performance is ascribed to better control over the recirculation regions. Slip factors were symmetric around the volute but were lower than for a single volute pump. Finally, momentum contributions to the total impeller radial load were shown to be maximum at the design point, contributing 40% of the force developed by the pressure distribution; the significance diminished at lower flow rates and the contribution was negligible at 40% of the design flow.

Nonlinear Mechanics/Dynamics

Researcher: Assistant Professor R. Raouf

This is a continuation of efforts to develop analytical models that describe the nonlinear static and dynamic responses of composite structures. This years efforts focused on toroidal geometry. The symbolic manipulator Mathematica was used to implement concepts and techniques of nonlinear elasticity and differential geometry to derive the nonlinear equations of motion of closed toroidal shells. Approximate solutions to these equations were constructed and the effects of various geometric and material properties were studied. The results have been submitted for publication in technical journals and presentation in conferences.

Redesign of an Engineering Experiment using a Computer

Researcher: Assistant Professor Colin Ratcliffe

Computers are increasingly used in engineering courses. This research considers a laboratory experiment that has been used for several years, and looks at how the analysis is enhanced when a personal computer is used. As a result of computer usage, students learn more about the engineering principles involved, while taking less time in completing the exercise. This research concentrates on a vibrations experiment, but the ideas presented are equally applicable to a variety of experiments in many engineering disciplines. The experiment investigates the transmissibility of a vibration isolation mount. Comprehensive curve-fitting algorithms are available for this type of data, but they use much more advanced theory than is required for the introductory course for which the experiment is set. This research shows a simpler, but less exact, method that is considered more appropriate for instructional purposes.

Avoiding Measuring Transfer Functions Inaccurately

Researcher: Assistant Professor Colin Ratcliffe

This report details an investigation into when some transfer functions can inadvertently be measured inaccurately. This investigation was conducted as a result of a request to the author to post process existing measured data. The request came from a knowledgeable person, who requested an invalid analysis. In addition, the author inadvertently measured incorrect data during an underwater acoustics experiment. This was because some of the assumptions made in a theoretical analysis are not always obvious in an experimental environment. This report concentrates on the problem associated with deriving mechanical transmissibility between two coordinates. It is shown that the transmissibility can only be determined from receptance data when the point receptance measurement at one of the coordinates is known. Deriving transmissibility from remotely

measured data produce inaccurate results. General recommendations for measurements are made.

Operator's Manual for the Solartron 1250/54 Frequency Response Analyzers Program (program version 2.0)

Researcher: Assistant Professor Colin Ratcliffe

The Solartron 1250/54 Frequency Response Analyzer is a powerful measurement device, used for student projects, staff research, and contract work. The analyzer is sold with an excellent GPIB capability, but there is no commercially available software. For more than trivial use, control by a host computer is essential. This report is the user manual for a PC program that is fully Windows 3.1 compatible. The program is highly flexible, and saves data to PC disk in a format readable by spreadsheets and word processors. In addition, the data can be converted into files compatible with the Structural Measurements Systems modal analysis package STAR.

Limitations on Transmissibility Measurements

Researcher: Assistant Professor Colin Ratcliffe

Many system functions cannot easily be measured directly, and have to be derived from alternative measurements. One example concerns the measurement of structural response due to acoustic excitation, and another example the calculation of the dynamic function transmissibility between two coordinates on a structure. Neither are easy to measure directly, and both can best be derived from alternative measurements. This research conncentrates on the problem associated with deriving mechanical transmissibility between two coordinates when only limited measurements are available. The theory which permits this post processing includes assumptions which may be forgotten by experimenters, and therefore the research investigates when approximations can be made. The ideas and cautions presented have a widespread application. It is shown that for most real mechanical systems, the transmissibility between two coordinates can only be determined from receptance data when the point receptance at one of the coordinates is known. Attempts to derive transmissibility from remotely measured data, without knowledge of the point measurement, will produce results that may seem to have the correct form, but are inaccurate. It is also shown that under certain conditions data measured from a remote site can sometimes be used successfully. The limitations are discussed.

Reducing the Vibrations Caused by a Marine Diesel Generator Set

Researcher: Assistant Professor Colin Ratcliffe

This research investigates the use of pneumatically controlled vibration absorbers to reduce the vibrations caused by a G&M/Perkins six-cylinder diesel generator (DG) set. The DG set had a mass of approximately 1 tonne and reductions in vibration levels near the engine mounts of about 10 dB were achieved using four absorbers with a total active mass of 18 kg.

The absorbers incorporated air springs which have the advantage of a variable stiffness depending on the contained air pressure within the springs. The ability to continuously tune to a target frequency was offset by the non-linear stiffness of the air springs, which makes control of the absorbers more complicated. For the work reported in this paper, the absorbers were manually tuned to the desired operating frequencies. Sensitivity trials for absorbers detuned from the optimum frequency are also reported.

Research Course Projects

Substrate Design for the Spray Forming Process

Researchers: Midshipman 1/C Michael P. Makela, USN,
Midshipman 1/C Timothy J. McDougall, USN
Adviser: Assistant Professor Angela Moran

The NSWC spray forming process has been expanded to produce not only simple, symmetrical shapes but complex, multi-axes parts as well. Substrates that can be removed from the final part are required to collect the spray deposit during the spray forming process. In this project, the midshipmen designed and manufactured disposable substrates for complex spray formed parts. Computer design methods and foundry techniques were utilized.

Particle Size Determination for the Spray Forming Process

Researchers: Midshipman 1/C Mathew A. Hawks, USN
Midshipman 1/C Eric L. Severseike, USN
Adviser: Assistant Professor Angela Moran

Spray forming involves the atomization of molten metals by inert gas. The spray formed particles fall onto a moving substrate to form the desired near-net-shape. Some of the particles do not fall onto the collector and these are accumulated as overspray powders for analysis. In this project, the midshipmen collected overspray powders from several spray forming runs and evaluated them in terms of size and microstructure to discern the effects of varied processing parameters on the sprayed deposits. ASTM standards for analysis and electron microscopy were utilized.

Heating, Ventilation and Air Conditioning (HVAC) for the Hybrid Electric Vehicle (HEV)

Researcher: Midshipman 1/C Michael Ray Cooper, USN
Adviser: Major Frank Madeka, USAF

The project proposed is the design of a heating ventilating and air conditioning system for the U. S. Naval Academy's Hybrid Electric Vehicle. The project will include a thermodynamic analysis of the vehicle's air conditioning/heating/defogging requirement's, a study of possible HVAC systems, and the construction of a defogging system.

Mini Baja Front Suspension Improvement

Researcher: Midshipman 1/C Dennis William Klein, USN
Adviser: Major Frank Madeka, USAF

The project will take a BAJA car from past competitions and redesign the suspension, braking and steering systems, in an attempt to qualify it for upcoming contests. This will include testing and evaluating all components including braking, springs, shocks, and various suspension arm configurations. After evaluating all the systems, a selection will be based upon criteria stressing safety; positive wheel lock protection; impact protection; braking distance and control; corner handling; ball joint connections; and endurance on all terrains including water.

Formula SAE Racer Front Suspension Design

Researcher: Midshipman 1/C Michael Raymond Hede, USN
Adviser: Major Frank Madeka, USAF

This project will design and analyze the front suspension system and braking for the Formula One Project. In the design planning, computers from CADIG will utilize the program FRAMES to come up with a spectrum of possible suspension parameters. These parameters will be analyzed to see which shock absorbers will meet the car's requirements.

Computer Aided Engineering of Laminated Structures

Researcher: Midshipman 1/C Stephen Albert Lipsey, USN
Adviser: Assistant Professor Raouf A. Raouf

Thick-section composites are gaining an increasing popularity in mission-critical components. However, the manufacturing process of these composites is known to introduce anomalies and imperfections such as layer waviness. This research uses the CAD and Finite Element capabilities of the software package I-DEAS to study the effects of layer waviness on the structural response of thick composite plates. Results show that layer waviness may cause an increase in interlaminar stresses which increases the probability of failure. On the other hand, the waviness could be "engineered" to reduce interlaminar stresses and reduce the probability of failure.

Optimization of Submarine Thermoelectric Coolers Incorporating Finite-Time Thermodynamics

Researcher: Midshipman 1/C Michael T. Brahan, USN
Adviser: Professor Chih Wu

Increasing attention has been paid to the research and development of thermoelectric coolers in recent years. Many of the advantages of thermoelectric coolers are only now being discovered. This paper examines from a theoretical standpoint the characteristics of thermoelectric coolers when applied to finitetime thermodynamics. In addition to the thermoelectric cooler, heat exchangers are added which connect it to a source and a sink. Using this setup, three methods of optimization are examined: maximum coefficient of performance, maximum cooling rate, and maximum temperature difference.

Publications

BARTON, Jr., O., Professor, and Reiss, R., "Bucking Analysis of Symmetric Laminated Plates Determined by Eigensensitivity Analysis", Proceedings of the 35th AIAA/ASME/ASCE/AHS/ASC Structures, Structures Dynamics and Material Conference, (18-21 April 1994), Hilton Head, SC, 2008-2018.

Closed-form approximate solutions for uniaxial and biaxial compressive buckling of rectangular symmetric angle-ply laminates are developed from eigensensitivity analysis. Boundary conditions, which consist of the various combinations of clamped and simply supported edges, are incorporated through appropriate edge condition parameters. Calculated results, presented for elastic moduli ratios up to 40, compare quite favorably with the corresponding buckling loads obtained from the Ritz method.

BARTON, Jr., O., Professor, and Reiss, R., "Vibration of Antisymmetric Laminated Plates Using Eigensensitivity Analysis," Advances in Computational Mechanics. CIVIL-COMP Ltd,. (1994). M Popadrakii and B.H.V. Toppings, Editors, 239-252.

Approximate closed-form expressions are developed to predict the vibration of rectangular angle-ply antisymmetric laminated composite plates. The set of partial differential equations is first represented in abstract form and then converted into discrete form using a Ritz approach. Sensitivity derivatives are determined which are used to provide a Maclaurin series representation of the laminate's frequency. A comparison of numerical results calculated for various boundary conditions using both the derived formula and the Rayleigh-Ritz method validates the accuracy of the approximate formula.

DAVIS, G. W., Assistant Professor, and WU, C., "Performance of a Geothermal-Heat-Engine-Driven-Air-Conditioning System," Proceedings of the First International Conference on New Energy Systems and Conversions,(1993), 503-507.

A geothermal-heat-powered-low-temperature Rankine cycle used to operate a conventional mechanical compression air conditioning cycle is feasible in providing cooling load. This paper employs a finite-time thermodynamic approach to analyze the performance of such a system. The only irreversibilities are associated with the heat transfers between the system and the surrounding thermal reservoirs. This approach provides a more realistic prediction of the performance than does the Carnot theoretical heat engine and air conditioning unit.

DAVIS, G. W., Assistant Professor, with HODGES, G. L., and MADEKA, F. C., "The Development of a Series Hybrid Electric Vehicle for Near-Term Applications," Proceedings of the 28th Intersociety Energy Conversion Engineering Conference, Vol 2, (1993) 239-244.

A series Hybrid Electric Vehicle(HEV) is currently under development for use in the Hybrid Electric Vehicle Challenge which is scheduled to take place during June of 1993. This competition, involving thirty universities from North America, is jointly sponsored by Ford Motor Company, the SAE International, and the U. S. Department of Energy. The U. S. Naval Academy's entry is a 5-door Ford Escort Wagon which has been converted to a series drive hybrid electric vehicle. The HEV entry is designed to be a feasible alternative to conventional,

gasoline powered vehicles, for use in near term applications. To accomplish this, all components are based upon existing technology. Further, this vehicle was designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle.

DAVIS, G. W., Assistant Professor, with HODGES, G. L., and MADEKA, F. C., "The Development of a Series Hybrid Electric Vehicle for Near-Term Applications," *IEEE Aerospace and Electronics Systems Magazine,* November (1993), 15-20.

A series Hybrid Electric Vehicle(HEV) has been developed by a team of midshipmen and faculty at the United States Naval Academy for use in the Hybrid Electric Vehicle Challenge which took place during June of 1993. This competition, involving thirty universities from North America, was jointly sponsored by Ford Motor Company, the SAE International, and the U. S. Department of Energy. The U. S. Naval Academy's entry is a 5-door Ford Escort Wagon which has been converted to a series drive hybrid electric vehicle. The HEV entry is designed to be a feasible alternative to conventional, gasoline powered vehicles, for use in near term applications. To accomplish this, all components are based upon existing technology. Further, this vehicle was designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle.

DAVIS, G., Assistant Professor, with BLANK, D., and WU, C., "Power Optimization of an Endoreversible Stirling cycle with Regeneration," *The International Journal of Energy,* Volume 19, No. 1, (1994), 125-133.

An optimal power analysis is conducted on an endoreversible Stirling cycle with perfect regeneration. The endoreversible cycle is one in which the external heat transfer processes are the only irreversible processes of the cycle. Maximum power and efficiency at maximum power are obtained for the cycle based upon higher and lower temperature bounds. These results provide additional criteria for use in the study and performance evaluation of Stirling engines.

DAVIS, G. W., Assistant Professor, with HODGES, G. L., and MADEKA, F. C., "The Development and Performance of the AMPhibian Hybrid Electric Vehicle," *SAE* 940337, (1994).

A series Hybrid Electric Vehicle(HEV) has been developed by a team of midshipmen and faculty at the

United States Naval Academy for use in the Hybrid Electric Vehicle Challenge which took place during June of 1993. This competition, involving thirty universities from North America, was jointly sponsored by Ford Motor Company, the SAE International, and the U. S. Department of Energy. A 5-door Ford Escort Wagon with a manual transmission has been converted to a series drive hybrid electric vehicle. The propulsion system is based on a DC motor which is coupled to the existing transmission. Lead-acid batteries are used to store the electrical energy. The auxiliary power unit (APU) consists of a small gasoline engine connected to a generator. The AMPhibian is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon existing technology. Further, this vehicle was designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle. The design specifications and the results of the performance and emissions testing are reported.

DAVIS, G. W., Assistant Professor, with MADEKA, F. C., and HODGES, G. L., "The Selection of Lead-Acid Batteries for use in Hybrid Electric Vehicles," *SAE* 940338, (1994).

Lead-acid batteries are currently the least expensive option for use in hybrid electric vehicles. The battery selection process for use in hybrid electric vehicles is complicated due to the limited use of these vehicles. Considerable data exists for the use of lead-acid batteries for other purposes. Unfortunately, much of this data is not directly applicable when these batteries are to be used in hybrid electric vehicles. Currently, there exists a wide variation in the type and format of battery data that is provided by the manufacturers. A comprehensive survey of heavy duty lead-acid batteries was conducted. Batteries were compared using manufacturer's published data. To provide a consistent basis for comparison, various performance parameters-energy capacity, ampacity, weight, and volume-were normalized with respect to both weight and volume. Additionally, all data was normalized to reflect three hour discharge rates. The battery selection process is then described in detail. Finally, recommendations are presented for the type and format of data that, if provided by the manufacturers, would greatly simplify this process.

FLACK, K.A., Assistant Professor, Johnston, J.P. "Near-wall Flow in a Three-Dimensional Turbulent Boundary Layer on the Endwall of a Rectangular Bend," AIAA 32nd Aerospace Sciences Meeting, (January 1994), 94-0405.

Turbulence measurements are reported for a three-dimensional turbulent boundary along the centerline of the flat endwall in a 30 degree bend. Profiles of Reynolds stresses were obtained in the outer flow and in the wall-layers down to $y^+=5$. Mean flow data collapsed well on a law-of-the-wall based on the resultant velocity. Mean velocity measurements, supported by a flow angle analysis, indicate that the flow is non-collateral near the wall even in the viscous sublayer.

The turbulence intensity and turbulent shear stress magnitude both increased downstream with increase of cross-flow three-dimensionality. However, the ratio of theses two quantities, the a structure parameter, decreased in the central regions of the boundary layer. In the near-wall region, al vs. y^+ showed profile similarity for $y^+<50$. The shear stress vector angle lagged behind the velocity gradient vector angle in the outer region of the boundary layer, but coincidence of these two-vectors was observed in the buffer layers near the region of maximum cross-flow.

FLACK, K.A., Assistant Professor, Johnston, J.P., "Advances in Three-Dimensional Turbulent Boundary Layers with Emphasis on the Wall-Layer Regions," 1994 ASME Fluids Engineering Division conference proceedings, (June 1994), 1-9.

This paper reviews some current information concerning three-dimensional turbulent boundary layers. Several topics are discussed including: (i) a detailed description of nine recent experimental studies of pressure-driven and wall shear-driven flows; (ii) the state of the art in measurement techniques; (iii) issues is turbulence modelling; (iv) and extension of recent work by others on questions concerning velocity profile similarity in the wall-layer regions; and (v) an introduction to new work on the visualization and description of quasi-coherent structures in three-dimensional boundary layers.

FLACK, K. A., Assistant Professor, Johnston, J.P.,, "Advances in Three-Dimensional Turbulent Boundary Layers with Emphasis on the Wall-Layer Regions," Thermosciences Division, Stanford University, Stanford CA, Report MD-67, (February 1994).

This paper reviews some current modelling problems concerning three-dimensional turbulent boundary layers.

The largest emphasis is placed on a detailed description of ten recent experimental studies of pressure-driven and wall shear-driven flows and the issue of modelling these flows. The idea of velocity profile similarity in the wall-layer regions, similar to the equations used for two-dimensional turbulent boundary layers, is explored as a modelling technique for these complex flows.

GILLERLAIN, J. D. Jr., Professor, with T. J. Waters and J. J. Zseleczky, "Force and Moment Measurements on a Series of Low Length/Beam Submarine Models: Phase I," (September 1993), USNA-EW-22-92.

The accurate prediction of the hydrodynamic characteristics of submersible vehicles is an important part of the design process. Whereas extensive data is available for submarines and torpedoes, very little information exists for hull geometries similar to swimmer delivery vehicles (SDV'S). The objective of the first phase of this fin/hull investigation was to characterize the fin/hull interference for a series of axisymmetric hull shapes of varying fullness fitted with flat plate fins. Force and moment data was obtained for three afterbody hull shapes in combination with variations of fin geometry to include fore and aft positions, chord length and span. The results provide an expanded database for low length/beam submarines models which to date has been scarce. The data provide a basis for further analytical treatment or for follow-on tests.

GRANGER, Robert A., Professor, *Experiments in Heat Transfer and Thermodynamics*, Cambridge University Press, New York, (1994).

It has been shown that we learn by doing. Perhaps engineering students especially will better understand the principles of heat transfer and thermodynamics by conducting experiments and seeing results.

This book presents a collection of experiments in heat transfer and thermodynamics contributed by leading engineering educators. The experiments have been tested, evaluated, and proved to be successful for classroom use. They are fun and challenging.

Each experiment follows a similar step-by-step format, which includes the objective of the experiment, apparatus needed, procedure, suggested headings, and references. The experiments use apparatus that is easily built or obtained.

Some of the topics covered are heat conduction, convection, boiling, mixing, diffusion, radiation, heat pipes and exchanger, and thermodynamics. Appendixes include lists of short experiments and demonstrations that have appeared in the literature, along with lists of available films and audiovisual materials and where to get them. Designed to serve as a companion to standard heat transfer and thermodynamics texts, this book will be a useful and appealing resource for engineering students.

GRANGER, Robert A., Professor,"*Fluid Mechanics*", Dover Publishing Co. Inc., New York, (1994).

This text is written for the student rather than for the instructor or critic. The text presents a unified method of analysis that is unashamed of the detail devoted to posing fluid mechanics problems in precise mathematical language without becoming stiff or unnecessarily rigorous. This method involves three steps: First, the text carefully defines each problem so that the student knows what is given and what is missing. Second, each chapter treats the physical aspects of the problem so that the student can visualize how things work in the real world. Third, the text represents the physical model by appropriate mathematical symbols and operations, collects these into equations, and then solves them. Thus, the physics is never lost and the mathematical procedures are strengthened through repetition of examples. The text further illustrates each new topic with relevant engineering examples. By these means the text blends the principles of fluid sciences with problem-solving skills purposefully structured so as to strengthen the skills of students who lack confidence in their mathematical ability. The goal of this text is to train students to think like highly skilled engineers, not like mere mechanical "plumbers" or unnecessarily abstruse theoreticians.

The text covers ideal and real fluids in internal and external flows using fixed and moving frames of reference. Cartesian, cylindrical, and intrinsic coordinate systems are all used, as well as vector and tensor notation. Some new material not covered in other fluid mechanics textbooks includes real vortex flows, detailed flow visualizations, new forms of differential linear momentum and certain energy loss expressions.

GRANGER, Robert A., Professor, "An Experimental Investigation of a Line Array of Charges Descending and Being Towed," USNA-EW-18-93.

Military interest exists in neutralizing embedded mines and explosives in a region of a surf. It is both time-consuming and dangerous to seek and destroy individual embedded explosives, and thus a more expedient method is required. One such scheme is to launch an array of explosives from a ship, such as an air-cushioned landing vehicle. Little is apparently known regarding two basic aspects of the line charge once it has been deployed from a launching platform. Its rate of

descent and displacement at a given instant of time through water at different sea states are unknown, as well as its configuration once it reaches the floor. The desired range of parameters includes sea state conditions, assorted axial spacing of the charges on the array, and numerous effective weights.

To study these two problems described above (the descent tests and the towing tests), the U.S. Naval Academy (USNA) working in concert with the Naval Surface Warfare Center, Coastal Systems Station, conducted an initial survey phase of experimental measurements during the period of 15 June - 23 August 1993 using the USNA's 380-foot Towing Tank facility.

HASSON, Dennis F., Professor, and L. A. Gish, "Effect of Exposure to High Temperature Air on the Impact Behavior of Uncoated and Flouromica Coated Nicalon Fiber Glass-CeramicComposites," Proceedings of the ASM 1993 Materials Congress, (October 1993), 235-239.

The impact behavior of uncoated and fluoromica coated Nicalon fiber reinforced glass ceramic matrix composites is described. The matrix was nominally calcium aluminosilicate (CAS). The undirectional composites contained 35-40 volume percent fibers. Both "as received" and specimens which were heated to 600°C in air for 10 hours were impact tested at room temperature. The "as received" fluoromica coated Nicalon fiber/CAS matrix composite exhibited higher energy absorption than the composite with uncoated Nicalon fiber. The effect of the high temperature oxidizing environment on the uncoated Nicalon/CAS composite was slight, while the effect on the fluoromica coated Nicalon/CAS II composite was significant. For the 600°C oxidizing condition the addition of the fluoromica coating does not provide enhanced oxidation embrittlement resistance.

HASSON, Dennis F., Professor, and M. K. Hamm, "The Effect of Temperature on the Impact Behavior of TiB_2 Reinforced XD^{TM}-TiAl Intermetallic-Matrix Composites," Proceedings of the ASM 1993 Materials Congress, (October, 1993), 249-255.

A study was performed to determine the effect of temperature on the impact behavior of two XD^{TM} processed TiB_2 reinforced TiAl intermetallic composites (IMC's). An existing instrumented tup drop tower apparatus was modified for the program. The IMC compositions were Ti-49 at .% Al + 5 vol.% TiB_2 and Ti-48 at .% Al + 10 vol.% TiB_2. The specimens were notched to an a/W ratio of 0.2. Details and test procedures for the modified apparatus are presented. Test

temperatures ranged from -192°C to 1100°C. Impact toughness and maximum bending stress for both IMC's decreased from room temperature to temperatures as high as 1100°C. An important experimental observation which supports these results is the change from transgranular cleavage to intergranular fracture at the 760°C test temperature. Also noted is the possible contribution to decreasing toughness of unfavorable difference in coefficient of thermal expansion between TiB_2 and the matrix with increasing temperature. Data repeatability and verification of the ability to observe high temperature brittle-to-ductile transition behavior established confidence in the modification of the existing instrumented tup apparatus.

JOYCE, James A., Professor, *Experimental Investigation of Fracture Toughness Scaling Models, Constraint Effects in Fracture: Theory and Applications*, ASTM STP 1244, Mark Kirk and Ad Bakker Eds., ASTM, Philadelphia, (1994).

An experimental investigation of fracture toughness in the ductile-brittle transition range was conducted. A large number of ASTM A533, Grade B steel, bend and tension specimens with varying crack lengths were tested throughout the transition region. Cleavage fracture toughness scaling models were utilized to correct the data for the loss of constraint in short carck specimens and tension geometries. The toughness scaling models were effective in reducing the scatter in the data, but tended to over correct the results for the short crack bend specimens. A proposed ASTM Test Practice for Fracture Toughness in the Transition Range, which employs a master curve concept, was applied to the results. The proposed master curve over predicted the fracture toughness in the mid-transition behavior of the material. Finally, the modified master curve and the fracture toughness scaling models were combined to predict the as-measured fracture toughness of the short carck bend and the tension specimens. It was shown that when the scaling models over correct the data for loss of constraining, they can also lead to non-conservative estimates of the increase in toughness for low constraint geometries.

JOYCE, James A., Professor, "Effects of Crack Depth and Mode of Loading on the J-R Curve Behavior of a High Strength Steel," Constraint Effects in Fracture, *ASTM STP 1171*, E. M. Hacket, et.al (eds), *American Society for Testing and Materials*, (1993), 239-263.

This paper describes an experimental program designed to develop a series of J-R curve data from laboratory

specimens of varied constraint. Constraint was varied by testing specimens with different thicknesses, crack lengths, and mode of loading. All specimens were relatively small and were kept simple in geometry and loading to allow estimation of the applied J integral. Crack length to width ratios varied dramatically from a/W = O.10 to a/W = 0.65 and the mode of loading ranges from three point bending of deeply cracked edge notched bars to pure tensile loading of double edge notched strips. All tests were conducted on a single material, a high strength structural steel, at ambient temperature, which is well up on the ductile upper shelf for this alloy.

Results of these tests have shown that different constraint conditions can dramatically affect the J_{ic} and the J-R curve for the full range of crack lengths and loading modes studied here, and these effects can be studied on relatively inexpensive laboratory specimens. Observed trends correspond to generally expected ideas of "increased constraint" or "decreased constraint" conditions, but since no factor is available to satisfactorily quantify constraint, an ability to utilize a data set such as this to predict the behavior of a material for a particular structural application is still lacking.

JOYCE, James A., Professor, and Link, R. E., "The Effect of Electric Discharge Machined Notches on the Fracture Toughness of Several Structural Alloys," USNRC, NUREG/CR-5981, Washington, DC, (September 1993).

Recent computational studies of the stress and strain fields at the tip of very sharp notches have shown that the stress and strain fields are very weakly dependent on the initial geometry of the notch once the notch has been blunted to a radius that is 6 to 10 times the initial root radius. If the fracture toughness of a material is sufficiently high so that fracture initiation does not occur in a specimen until the crack-tip opening displacement (CTOD) reaches a value from 6 to 10 times the size of the initial notch tip diameter, then the fracture roughness will be independent of whether a fatigue crack or a machined notch served as the initial crack.

In this experimental program the fracture toughness (J_{ic} and J resistance (J-R) curve, and CTOD) for several structural alloys was measured using specimens with conventional fatigue cracks and with EDM machined notches. The results of this program have shown, in fact, that most structural materials do not achieve initiation CTOD values on the order of 6 to 10 times the radius of even the smallest EDM notch tip presently achievable. Furthermore, the tougher materials do not seem to be less dependent on the type of notch tip present. Some materials are shown to be much more dependent on the type of initial notch tip used, but no simple pattern is found that relates this observed dependence to the material strength, toughness, or strain hardening rate.

LOPARDO, V. J., Professor, with C. Wu, R. L. Kiang and G. N. Karpouzian, "Finite-Time Thermodynamics and Endoreversible Heat Engines," *Journal of Mechanical Engineering Education*, v. 21, #4, (1993), 337-346.

An endoreversible heat engine is an internally reversible and externally irreversible cyclic device which exchanges heat and power with its surroundings. Classical engineering thermodynamics is based on the concept of equilibrium. Time is not considered in the energy interactions between the heat engine and its environment. On the other hand, although rate of energy transfer is taught in heat transfer, the course does not cover heat engines. The finite-time thermodynamics is a newly developing field to fill in the gap between thermodynamics and heat transfer. The reciprocating and steady flow engine types are modelled in this paper with results obtained for maximum power output and efficiency at maximum power. It is shown that the latter is the same for both types of engines but that the maximum value of power production is different.

MORAN, Angela L., Assistant Professor, with R. Payne and R. Cammarata, "Relating Porosity and Mechanical Properties in Spray Formed Tubulars," *Scripta Metallurgica et Materialia*, 907.

Many new alloys offer significant improvements in strength, hardness and corrosion resistance, but they are also difficult and expensive to fabricate using conventional processing techniques. One approach to reducing production costs has been to pursue near net shape manufacturing techniques that involve less working and shaping. Osprey Metals, Ltd. has developed a near-net shape alloy production method, spray forming, which reduces the number of production steps. The technique combines the multiple step methods of powder processing and has other benefits, such as improved product quality, in addition to reduced manufacturing costs.

While spray forming could potentially reduce the cost of alloy production, it is not a well understood process and correlations between process parameters and quality are not well established. Because the spray forming process holds the potential to reduce the cost of alloy production, there is significant interest in developing methods to industrialize and automate this

rocess through advanced sensing techniques. These advanced sensing techniques will observe the process real-time and give inputs to a process controller. By determining relationships between part quality, process parameters, and sensor inputs, the process controller will be able to determine the quality of a part while it is being made and make adjustments if necessary.

The first step in developing advanced sensing techniques is to define the characteristics of a desired product Once the characteristics of a good quality part are established, sensors can be developed to evaluate these characteristics. In previous work (1,2), porosity was chosen as the primary characteristic to assess part quality. However, attempts to establish a relationship between porosity and data from a surface roughness sensor met with limited success (2).

In this study, quality is assessed in terms of mechanical properties on the principle that stronger materials will be in service for longer periods of time and will therefore be cheaper and better. The relationship between mechanical properties and porosities for individual parts are also evaluated and alternate methods of determining porosity are compared. The main objective is to determine whether porosity is a valid indicator of quality.

MORAN, Angela L., Assistant Professor, with C. Madden and R. Rebis, "U.S. Navy Research and Development Programmes for Spray Forming," Powder Metallurgy, 36(4), (1993), 252-254.

Over the past five years, the Annapolis Detachment, Carderock Division, Naval Surface Warfare Center (formerly David Taylor Research Center) has established a state-of-the-art spray forming facility for the study and exploitation of this near net shape manufacturing process. Spray forming is a single step gas atomization/deposition process which yields ferrous and non-ferrous, near final shape, near fully dense preforms. In the Osprey spray forming process, molten metal is rapidly atomized to form a fine spray of particles that are deposited onto a collector or mandrel at rates of up to 400 pounds per minute. The microstructure of the as-deposited preform is fine-grained and uniform with minimum microporosity. Spray forming has proven to be a viable and cost effective alternative to conventional metalworking technology for the production of material preforms with properties surpassing those of their cast and wrought counterparts. Current programs at Carderock Division Naval Surface Warfare Center are aimed at optimization of the process, certification of the spray formed products and industrialization of the technology.

MORAN, Angela L., Assistant Professor, with R. Payne and R. Rebis, "Spray Forming Quality Predictions via Neural Networks" *Journal of Materials Engineering and Performance.*, 2(5), 1.

To produce consistently high-quality spray-formed parts, correlations must be made between the input process parameters and the final part quality. The Spray Forming Technology Group at the Naval Surface Warfare Center decided to "model" this correlation through the use of artificial neural networks. In this study, neural networks accurately predicted trends in spray forming process outputs based on variations in process inputs. The graphs generated by the neural network prediction help to define the optimal operating region for the spray forming process and indicate the effect of changing input process parameters on final part quality.

MORAN, Angela L., Assistant Professor, with R. Payne and M. Matteson, "The Application of Neural Networks to Spray Forming," *International Journal of Powder Metallurgy*, (October 1993), 345-351.

Recent work in the intelligent spray forming program at the Naval Surface Warfare Center has led to the development of a surface roughness sensor for the measure of real time spray formed part quality. Artificial neural works were used to correlate test run data from this surface roughness sensor and other sensors with spray formed preform characteristics. Neural networks can mimic a human operator's thought process and in this study were successfully used to predict values for process outputs.

While many superalloys offer improvements in strength, hardness and corrosion resistance, they are also difficult and expensive to fabricate using conventional processing techniques. One approach to reducing production costs has been to pursue near net shape manufacturing techniques that involve less work and machinery than traditional methods. Osprey Metals, Ltd. has developed a spray forming near-net shape alloy production method which reduces the number of production steps. while offering improved product quality and reduced manufacturing costs.

Although spray forming could potentially reduce the cost of alloy production, correlations between process parameters and final part quality are not well established. As a result, an empirical form of modeling has been developed using advanced sensing techniques and neural networks. In this paper, neural networks are used as a tool to determine if there is a relationship between spray forming process parameters and quality. This study serves to assess the validity and limitations in using

neural networks to predict quality in spray formed parts.

MORAN, Angela L., Assistant Professor, with A. Leatham, "Spray Forming of High Strength, Lightweight Alloys and Composites," Proceedings of the 40th Sagamore Conference, (August 1993), 215-220.

Spray forming is a single step, gas atomization/deposition process which yields near final shape, fine-grained, segregation-free preforms in ferrous and non-ferrous alloys. For many applications, the Osprey spray forming process is proving to be a viable and cost effective metalworking technology for manufacturing products with properties surpassing those of their cast wrought and/or PM counterparts. This is shown to be particularly true for aluminum alloys and MMCs. Significant improvements in damage tolerance have been demonstrated for standard 2000 or 7000 series alloys due to refinements in grain structure, primary phases, and intermetallics. Taking advantage of rapid solidification and low oxygen contents, new 2000 and 7000 series alloys have also been developed with further enhancement of properties. In the Al-Li field the two main drawbacks of DC-cast products (i.e. low transverse ductility and stress corrosion resistance) have been overcome using the Osprey Process. In addition, a new series of ultra-lightweight alloys have been developed. Additionally, a Navy R&D development program is currently underway to assess the benefits of spray forming another light alloy, titanium.

MORAN, Angela L., Assistant Professor, with R. Rebis, C. Madden and R. Payne, "High Deposition Rate Spray Forming for Military Applications," First International Conference on Processing Materials for Properties (H. Henein and T. Oki, editors) TMS,(1993),. 633-635.

Over the past four years, the Annapolis Detachment, Carderock Division, Naval Surface Warfare Center (formerly David Taylor Research Center) has established a state-of-the-art spray forming facility for the study and exploitation of this near net shape manufacturing process. Spray forming is a single step gas atomization/deposition process which yields ferrous and non-ferrous, near final shape, near fully dense preforms. In the Osprey spray forming process, molten metal is rapidly atomized to form a fine spray of particles that are deposited onto a collector or mandrel at rates up to 400 pounds per minute. The microstructure of the as-deposited preform is fine-grained and uniform with minimum microporosity. Spray forming has proven to be a viable and cost effective alternative to conventional metalworking technology for the production of material preforms with properties surpassing those of their cast and wrought counterparts. Current programs at Carderock Division

Naval Surface Warfare Center are aimed at optimization of the process, certification of the spray formed products and industrialization of the technology.

MORAN, Angela L., Assistant Professor, with M. Matteson, R. Payne and C. Madden, "An Approach to Modelling the Spray Forming Process with Artificial Neural Networks," International Conference on Spray Forming Proceedings, (Sept 1993), 105-116.

In this study artificial neural networks were used to model the spray forming process. Networks were developed and trained using process parameter and product quality data collected from a series of five spray forming runs. Process parameters of time into run, melt temperature, and gas to metal ratio were used as inputs and then networks were trained to predict the corresponding values of exhaust gas temperature, preform surface roughness, and porosity in the product. These networks were then tested with actual and hypothetical data. The results of the study showed that the networks can determine relationships between process parameters and the end product quality. It was also shown that the networks can be used to predict the effect on product quality from changes in process parameters. Additional work is in progress to create a larger data set for training over a broader region of the operating envelope. The result of this ongoing work will provide greater reliability in network prediction.

MORAN, Angela L., Assistant Professor, "Industrialization and Certification of Large Diameter Spray Formed Superalloy Components for Military Applications," International Conference on Spray Forming Proceedings, (Sept 1993), 165-170.

Spray forming is a single step, gas atomization/deposition process which yields ferrous and non-ferrous, near final shape, near fully dense preforms. In the Osprey spray forming process, molten metal is rapidly atomized to form a fine spray of particles that are deposited onto a collector or mandrel at rates up to 400 pounds per minute. The microstructure of the as-deposited preform is fine-grained and uniform with minimum microporosity. Spray forming has proven to be a viable and cost effective alternative to conventional metalworking technology for the production of material preforms with properties surpassing those of their cast and wrought counterparts. Current programs at Carderock Division Naval Surface Warfare Center are aimed at optimization of the process, certification of the spray formed products and industrialization of the technology.

MORAN, Angela L., Assistant Professor, with C. Madden, R. Rebis, R. Payne and M. Matteson, "Spray Forming Technology for Military Applications," Proceedings of the 1993 National Thermal Spray Conference, (June 1993), 655-659.

In the Osprey spray forming process, molten metal is rapidly atomized to form a fine spray of particles that are deposited onto a collector or mandrel at rates up to 400 pounds per minute. The microstructure of the as-deposited preform is fine-grained and uniform with minimum microporosity. Spray forming has proven to be a viable and cost effective alternative to conventional metalworking technology for the production of material preforms with properties surpassing those of their cast and wrought counterparts. Current programs at Carderock Division Naval Surface Warfare Center are aimed at optimization of the process, certification of the spray formed products and industrialization of the technology. This includes the development of real-time sensors interfaced with an automated fuzzy logic controller and expanded motion control system. The objective of this program is to develop sensor and control technology to monitor the critical process conditions and to modify parameters during the process to produce asymmetric components with repeatable microstructural quality. Results from the intelligent processing program will be combined with other Navy developments in optimization of the spray forming process and integrated into a large pilot plant facility. The objective of a Manufacturing Technology program is to industrialize the spray forming manufacturing process in the United States to reduce the cost of military components and to enhance the global competitiveness of U.S. industry. Navy applications including torpedo tubes, shaft seals and sleeves, piping and bearings are being addressed. In addition, other service applications that have been identified will be evaluated and cost-effectiveness determined.

MORAN, Angela L., Assistant Professor, "Particle Size Determination of Spray Formed Overspray Powders" with E. Severseike and M. Hawks, USNA Report EW-09-94, (July 1994).

High deposition spray forming exhibits the beneficial characteristics of powder metallurgy while improving on ingot metallurgy to produce high density, near-net-shape preforms. The technology is applicable to a wide range of naval materials. One by product of spray forming is overspray powder, the metal from the atomized melt that has missed the collector. This report investigates characterization and particle size distribution of the

overspray powders from seven spray forming runs and four different alloys. It also explores the disposal and re-use of these powders.

MORAN, Patrick J., Associate Professor, co-author, "Hydrogen Cracking Initiation of a High Strength Steel Weldment", ASTM Special Technical Publication # 1210, Slow Strain Rate Testing for the Evaluation of Environmentally Induced Cracking: Research and Engineering Applications, R.D. Kane, Ed., *ASTM*, Philadelphia, PA, (1993), 202-222.

The hydrogen assisted crack initiation susceptibility of 5-Ni-Cr-Mo-V (Mil-S-24371A) quenched and tempered steel plate, weldment, and Gleeble thermal cycled materials representative of tempered and untempered weld metal, was investigated in 3.5% NaCl solution. The conjoint role of steady state diffusible hydrogen content and maximum principle stress was quantitatively characterized by: (1) Devanathan-Stachurski hydrogen permeation test, and (2) slow strain rate test conducted under various cathodic protection levels.

For the four material conditions studied, the threshold maximum principal stress decreased with increasing hydrogen concentration. The base plate was less susceptible to hydrogen assisted crack initiation than the weld metal and thermal cycle weld metals. The tempered and untempered thermal cycled weld materials defined the upper and lower bounds of the as-welded material cracking susceptiblity respectively.

MORAN, Patrick J., Associate Professor, co-author, "A Microellipsometric Study of the Passive Film Formation on Al-Ta Alloys: Part I. Solid Solution Alloys", *Journal of the Electrochemechanical Society*, (May 1994), 1126-1131.

Solid-solution Al-Ta alloys possess significantly higher pitting potentials than pure aluminum in Cl⁻ solutions. Dynamic imaging microellipsometry was used to study the passive film formation on solid solution Al-Ta alloys. Film thickness was measured during growth for alloy compositions of pure Al, Al-8 a/o Ta, Al-25 a/o Ta and pure Ta at applied potentials of 0.0, 1.0, 2.0, and 5.0 V SCE in a pH 7.2 borate buffer. Increasing the concentration of tantalum resulted in the formation of thinner passive films at all applied potentials. On pure Al and Al-8 a/o Ta, precipitation of an $Al(OH)_3$ type film results in a linearly increasing film thickness with time. The relationship of film thickness measurements to the enhanced localized corrosion resistance is discussed.

MORAN, Patrick J., Associate Professor, co-author, "A Microellipsometric Study of the Passive Film Formation on Al-Ta Alloys: Part II. The Role of Al3Ta Precipitates in Breakdown", *Journal of the Electrochemechanical. Society*, (May 1994), 1132-1137.

Al_3Ta precipitates act as sites for pit initiation and propagation in Al-Ta alloys. Dynamic imaging microellipsometry was used to measure the change in oxide film thickness and the refractive indexes of the films that form on the precipitates and matrix to examine the role of the precipitates in breakdown. Film formation was measured on an Al-1.5 a/o Ta alloy containing Al_3Ta precipitates approximately 50 μm in diameter at applied potentials of 0.0, 1.0, 2.0, and 5.0 V SCE in a pH 7.2 borate buffer solution. At 0.0 V SCE the change in passive film thickness on the precipitate was greater than that on the Al matrix. The changes in film thicknesses at 1.0 V SCE were approximately equal. At higher potentials (2.0 and 5.0 V SCE) the matrix film thickened more than the film on the precipitate. SEM observations demonstrate that the precipitate-matrix interface is highly susceptible to localized attack when the passive film on the Al_3Ta is thicker than on the matrix (at 0.0 V SCE). This study proposes that pit initiation occurs at both the interface of the Al_3Ta precipitation and in the dealloyed region around its periphery.MORAN, Patrick J., Associate Professor, co-author, "The Effects of Water on the Passive Behavior of 1018 Carbon Steel in Organic Solutions",*Journal of the Electrochemechanical Society*, (April 1994), 934-939.

The passivation and breakdown behavior of 1018 carbon steel in propylene carbonate (PC) or dimethoxyethane (DME) mixtures with water containing 0.5M $LiAsF_6$ were studied. The behavior of the steel in the organic solvent/water mixtures was highly dependent on the organic solvent. The anodic polarization of carbon steel displayed active-passive behavior in 10-90 mole percent (m/o) PC/H_2O mixtures and a tenuous degree of stability within the passive range. The anodic polarization of carbon steel displayed no active-passive behavior in 50-90 m/o DME/H_2O mixtures and displayed active-passive behavior in 10-30 m/o DME/H_2O mixtures. The steel was stable within the passive range of these DME/H_2O solutions. The breakdown potential of the steel in DME/H_2O mixtures is more electropositive than the oxidation potential of the DME solvent at all molar ratios.

MORAN, Patrick J., Associate Professor, co-author, "Evaluation of the Corrosion Behavior of Nitrogen Atomized 304L Stainless Steel", USNA-EW-14-93,

This work was conducted at the United States Naval Academy in the Materials Science Laboratory of the Mechanical Engineering Department. Dr. Streinz was supported by the Office of Naval Technology Postdoctoral Fellowship Program during this investigation. The nitrogen and argon atomized stainless steel samples were supplied by Francis S. Biancaniello of the Metallurgy Division of the National Institute of Standards and Technology in Gaithersburg, MD.

The effect of nitrogen atomization, followed by HIP consolidation, on the pitting and crevice corrosion resistance of an austenitic stainless steel (type 304L) was examined. The corrosion behavior of a nitrogen atomized 304L alloy containing 23 w/o Cr and 0.21 w/o N_2 was compared with that of an argon atomized 304L alloy containing 18.5 w/o Cr and 0.03 w/o N_2 and that of a cast 304 alloy. It was observed that nitrogen atomization increased the pitting potential by at least 1.0 V to a value of over 1.1 V vs. SCE. The resistance to crevice corrosion was also observed to increase dramatically, with nitrogen atomized samples exhibiting stable passivity in the presence of crevices while being potentiostatically held at potentials higher than the pitting potentials of either the argon atomized 304L or the cast 304. Finally, it was shown that the observed pitting resistance of the nitrogen atomized alloy is superior to that expected based on nitrogen concentration in similar alloys produced by traditional methods. This suggests a synergistic affect between the nitrogen additions and the processing method employed.

MORAN, Patrick J., Associate Professor, co-author, "The Passivity of Carbon Steel in Organic Solutions", Proc. 12th International Corrosion Congress, Houston, TX, Sept 19-24, NACE International, Houston, TX, (1993), 2131-2141.

The passivation and breakdown behavior of 1018 carbon steel in anhydrous solutions of propylene carbonate (PC) or dimethoxyethane (DME) containing 0.5M LiAsF6 was studied. Results have indicated that for anodic potentials several passivation mechanisms (e.g. air-formed film, solvent adsorption, salt film formation, electropolymerization, and oxide formation) are operative. Each passivation mechanism is strongly dependent on the metal or alloy composition, the potential, the solvent, and the electrolyte. The addition of small amounts of water to PC or DME changes the character of the passive film and the balance between competing mechanisms.

MECHANICAL ENGINEERING

MORAN, Patrick J., Associate Professor, co-author, "Crevice Corrosion of a Nickel-Based Superalloy in Natural and Chlorinated Seawater", Proc. 12th International Corrosion Congress, Houston, TX, Sept 19-24, NACE International, Houston, TX, (1993), 1915-1928.

Alloy 625 is a high strength, corrosion resistant Ni-Cr-Mo-Fe alloy that is being used increasingly by the chemical and offshore power industries in environments where stainless steels suffer severe localized corrosion. Alloy 625 exhibits excellent resistance to pitting, but has been found to be susceptible to crevice corrosion in seawater and in oxidizing environments such as chlorinated seawater. In order to investigate the mechanism of crevice corrosion for alloy 625 and to assess the role that chlorination plays in crevice corrosion propagation a three fold approach was taken: 1) simulated environments corresponding to those present during the initiation and propagation stages of crevice corrosion were chosen based on mathematical model predictions, information in the literature, and actual measurements; 2) steady state polarization behavior for alloy 625 in environments corresponding to those found inside and outside an active crevice was ascertained. Anodic polarization curves were generated in these simulated crevice environments and cathodic polarization curves were generated in natural seawater and chlorinated seawater; and 3) mixed potential theory, including the effects of IR drop down a crevice, was applied to the polarization data to identify the crevice corrosion mechanism in natural seawater and to determine the role that chlorination plays in crevice corrosion propagation.

A mixed potential analysis utilizing an anodic polarization curve for alloy 625 generated in an environment simulating that found inside a crevice at initiation and a cathodic polarization curve generated in natural seawater reveals that crevice corrosion initiates by an IR induced mechanism. During the propagation stage, mixed potential analysis reveals that the diffusion controlled portion of the oxygen reduction reaction drives crevice corrosion. In low level chlorinated seawater (1 mg/l total residual oxidant) it is the reduction of Hob and OBr- and not O_2 that drive crevice corrosion propagation. The limiting current density for the reduction of Hob/OBr- in the chlorinated environment is two orders of magnitude lower than the limiting current density for oxygen reduction in natural seawater and is responsible for the lower crevice corrosion rates observed in low level chlorinated seawater.

RAOUF, Raouf A., Assistant Professor, "A Qualitative

Analysis of the Nonlinear Characteristics of Curved Orthotropic Panels," *Composites Engineering*, v. 3, #12, (1993), 1101-1110.

This paper presents a qualitative study of the nonlinear free vibration characteristics of curved, simply supported, orthotropic panels. The panels are modeled using the Donnell-Mushtari-Vlasov shell relationships. An approximate solution to the resulting nonlinear equations is constructed using the Galerkin procedure in the spatial domain and the Lindstedt-Poincare perturbation technique in the temporal domain. The combination of these procedures is implemented using the symbolic manipulator Mathematica. The analysis shows that although the transverse displacement may be assumed to have a single mode, the compatibility condition forces the in-plane stress resultants to be multi-modal. It is shown that the type of nonlinearity that the panel exhibits is strictly cubic if either of the axial or circumferential modes is asymmetric. On the other hand, the nonlinearity is both quadratic and cubic for axisymmetric modes. Numerical simulations using various geometric and material properties show that the response of the first modes of the panel could be either hardening or softening depending on the geometric and material properties of the panel. On the other hand, the response of the higher modes for the studies cases is always hardening. Numerical results also suggest that it is possible to tailor the dynamic response of some panels to produce softening or hardening behaviors.

RAOUF, Raouf A., Assistant Professor, with A. N. Palazotto, "On the Nonlinear Free Vibrations of Curved Orthotropic Panels," *International Journal of Nonlinear Mechanics*,vol. 29, 4, (1994), 507-514.

This paper studies the non-linear free vibrations of simply supported curved orthotropic panels. The panels are modeled using the Donnell-Mushtari-Vlasov shell relationships. A combination of the Galerkin procedure and the Lindstedt-Poincare perturbation technique is used to construct an approximate solution to the resulting non-linear equations of motion. Algebraic manipulations show that the panel exhibits a non-linear response only when both the involved axial and circumferential modes are axisymmetric. Numerical studies of a Graphite/Epoxy panel show that its response is softening, i.e. the non-linear natural frequency decreases as the amplitude of motion increases. They also show that the lower modes are more non-linear than the higher, mainly flexural modes. The presented results also show that for the studied panels, the non-linear effects are the strongest for shallow, thin, and short panels.

RAOUF, Raouf A., Assistant Professor, "Effects of Layer Waviness on Interlaminar Stresses in Thick Composite Plates," Proceedings of the American Society for Composites Eigth Technical Conference, (1993), 602-607.

Recent years have witnessed an increase in the popularity of thick-section composites in mission-critical components. However, the manufacturing processes of these composites are known to introduce anomalies and imperfections that are difficult to eliminate, such as layer waviness (i.e., local undulations in the layers). Accordingly, there is a demand for more accurate models to study the effects of such imperfections on the behavior of these structures. The present study shows that layer waviness in thick composites may cause a significant increase in interlaminar normal and shear stresses in its vicinity. Maximum interlaminar stresses occur for a waviness with amplitude-tospan ratio of about ±0.5. Results also show that these maximum stresses occur close to the foot of the wave.

RAOUF, Raouf A., Assistant Professor, with A. N. Palazotto, "The Dynamics of an Orthotropic Torus Undergoing Large Deformations," *AIAA* paper no. AIAA-94-1348-CP.

This paper models the nonlinear dynamic behavior of closed, elastic, toroidal shells. Differential geometry is used to derive the nonlinear kinematic relationships and a combination of the Rayleigh-Ritz technique and the method of harmonic balance is used to approximate the nonlinear natural frequency of the torus. A numerical example of a unidirectional composite torus shows the linear natural frequency increases as the fiber volume fraction increases. The fiber volume fraction also controls the nonlinear dynamic characteristics of the torus.

RAOUF, Raouf A., Assistant Professor, "Dynamics of Laminated Plates with Layer Waviness," Engineering, Construction, and Operation in Space IV Conference, Vol. 1, (1994), 109-115.

Composite structures usually exhibit a high strength-to-weight ratio as compared to traditional structural materials. This makes them attractive solutions in many aerospace applications. Accordingly, it becomes important that the behavior of these structures be modeled as realistically as possible to predict their response under actual operation conditions. The present paper studies the effects of manufacturing imperfections on the dynamics of laminated plates. The imperfections are modeled as a layer waviness at the edge of the plate,

i.e., a local undulations in the interface between layers. Numerical simulations show that layer waviness may increase or decrease the natural frequency of a laminated plate. However, for the studied case, the dominant effect is to decrease the natural frequency.

RATCLIFFE, Colin, Assistant Professor, with M. J. Day, "Redesign of an Engineering Experiment Using a Computer,"*International Journal of Mechanical Engineering Education,* v. 21, #1, (1993), 327-332.

Computers are increasingly used in engineering courses. This paper considers a laboratory experiment that has been run for several years, and looks at how the analysis is enhanced when a personal computer is used. As a result of computer usage, students learn more about the engineering principles involved, while taking less time in completing the exercise. The paper concentrates on a vibrations experiment, but the ideas presented are equally applicable to a variety of experiments in many engineering disciplines.

The experiment investigates the transmissibility of a vibration isolation mount. Comprehensive curve-fitting algorithms are available for this type of data, but they use much more advanced theory than is required for the introductory course for which the experiment is set. This paper shows a simpler, but less exact, method that is considered more appropriate for instructional purposes.

RATCLIFFE, Colin, Assistant Professor, with R. M. Crane, "Graphite/Polyurethane Flexible Composites - Mechanical Vibration Damping Properties," CARDDIVNSWC-TR-601-93/02.

Structures fabricated with advanced composite materials, such as graphite fibers in thermoset or thermoplastic resins, typically possess high stiffness. The material is elastic to failure, which occurs at strain levels which are relatively low, on the order of 2 to 5 % depending on fiber orientations. There are numerous naval applications in which systems are subjected to significantly large deformations due to the global deformation of the ship hull. To allow the subsystems to function while being subjected to these large global deformations, flexible couplings are often incorporated. These couplings must transfer in-plane loads and torque while allowing for dissimilar motion of each component. This paper describes such a structural configuration which is both flexible and structurally adequate to support significant mechanical loads. This flexible composite system consists of a braided graphite fiber preform infiltrated with a polyurethane, Adiprene, which has a modulus of 1100 psi and a strain to failure of 300%. This composite

system possesses adequate structural characteristics of strength and stiffness, and the capability to undergo large global deformations while simultaneously dissipating significant levels of mechanical vibration energy. This paper discusses the fabrication and design of the flexible composite material, the mechanical characteristics, and the damping that it provides.

RATCLIFFE, Colin, Assistant Professor, with M. J. Day, R. J. Randall and E. Rider, "Reducing the Vibrations caused by a Marine Diesel Generator Set," *Proc. Instn. Mech. Engrs.*, v. 207, (1994), 375-381.

This paper details work undertaken to investigate the use of pneumatically controlled vibration absorbers to reduce the vibrations caused by a G&M/Perkins six-cylinder diesel generator (DG) set. The DG set had a mass of approximately 1 tonne. Reductions in vibration levels near the engine mounts of about 10 dB were achieved using four absorbers with a total active mass of 18 kg. The absorbers incorporated air springs which have the advantage of a variable stiffness depending on the contained air pressure within the springs. The ability to continuously tune to a target frequency was offset by the non-linear stiffness of the air springs, which makes control of the absorbers more complicated. For the work reported in this paper, the absorbers were manually tuned to the desired operating frequencies. Sensitivity trials for absorbers detuned from the optimum frequency are also reported.

RATCLIFFE, Colin, Assistant Professor, "Vibration Analysis of Fire Protection Panels", EW-13-93, (August 1993).

This report details the vibration measurement of fire protection panels. One plate was analyzed both before and after fire testing, and the remaining three were only analyzed after fire testing. The results obtained from this analysis were natural frequencies, mode shapes at resonance, and modal damping. The plate analyzed before and after fire testing was a triple skin box section. The modal comparison showed that as a result of fire testing, all natural frequencies increased, and all viscous damping ratios decreased.

The post fire testing analysis of the other plates showed that local structural weakening could be identified through irregularities in mode shapes. Data from before the fire testing was not available, and therefore no comparison of mode shapes and modal damping could be made.

RATCLIFFE, Colin, Assistant Professor, "The Effects of

Preload and Contamination on the Performance of Wire Wound Vibration Isolation Mounts", EW-20-93, (October 1993).

This report details an ongoing investigation into the dynamic properties of a wire wound shock and vibration isolation mount manufactured by Aeroflex. Earlier work with the mount suspended on rubber bungee cords, showed it was nonlinear in terms of both stiffness and damping. This report includes details of transmissibility and mechanical impedance measurements of the mount under various load conditions. In addition, it reports the effect of oil and dirt contamination on the performance of the mount.

Opportunity was taken to compare transmissibility estimation from the direct ratio of force measurements, to that obtained from a post calculation of receptance data.

RATCLIFFE, Colin, Assistant Professor, "Avoiding Measuring Transfer Functions Inaccurately," EW-15-93, (September 1993).

This report details an investigation of several transfer functions that can inadvertently be measured inaccurately. This investigation was conducted as a result of a request to the author to post process existing measured data. The request came from a knowledgeable person, who requested an invalid analysis. In addition, the author inadvertently measured incorrect data during an underwater acoustics experiment. This was because some of the assumptions made in a theoretical analysis are not always obvious in an experimental environment.

This report concentrates on the problem associated with deriving mechanical transmissibility between two coordinates. It is shown that the transmissibility can only be determined from receptance data when the point receptance measurement at one of the coordinates is known. Deriving transmissibility from remotely measured data produce inaccurate results. General recommendations for measurements are made.

RATCLIFFE, Colin, Assistant Professor, "An Investigation into the Performance of a Rubber and Composite Vibration Isolation Mount Subject to a Shock Test," EW-02-94, (February 1994).

This report investigates the performance of a vibration isolation mount when subjected to a shock test. For the test the vibration mount has a load secured to it, and the combination is fastened to a shock table. The test comprises of an initial rise of the shock table, which is then abruptly snubbed. This report analyzes the initial rise of the shock table with the mount and load on it.

Inspection of load vs. deflection data for the mount shows that for moderate amplitudes it can be considered linear. Therefore this report assumes linearity, and applies a modal decomposition, time solution and modal superposition.

A numerical example using typical values shows that even during the initial rise of the shock table the deformation of the mount is such that linearity cannot be assumed. However, the concepts derived in this report are valid for lesser shocks or more linear mounts, and warrant further investigation. A nonlinear analysis of the motion is presented in a later report.

RATCLIFFE, Colin, Assistant Professor, "Operator's Manual for the Solartron 1250/54 Frequency Response Analyzers Program (program version 2.0)," EW-03-94, (March 1994).

The Solartron 1250/54 Frequency Response Analyzer is a powerful measurement device, used for student projects, staff research, and contract work. The analyzer is sold with an excellent GPIB capability, but there is no commercially available software. For more than trivial use, control by a host computer is essential.

This report is the user manual for a PC program that is fully Windows 3.1 compatible. The program is highly flexible, and saves data to PC disk in a format readable by spreadsheets and word processors. In addition, the data can be converted into files compatible with the Structural Measurements Systems modal analysis package *STAR*.

RATCLIFFE, Colin, Assistant Professor, "Investigation into the Dynamic Behavior of an Aeroflex Wire Wound Vibration Isolation Mount," EW-17-93, (September 1993).

This report details the results of an investigation into the dynamic properties of a shock and vibration isolation mount manufactured by Aeroflex. The mount is designed for marine applications, and consists of approximately 1 inch stainless steel rope, coiled into 8 loops, each approximately 5 inches in diameter. The rope is constrained into this configuration by top and bottom metal bars, which also serve as load and mounting platforms.

The tests were designed to determine the transmissibility of the mount. The mount was nonlinear, and damping and resonant frequencies were estimated as a function of excitation level. The tests reported here, which are the first of a series, were conducted with the mount suspended on rubber bungee cords. The results include a modal analysis, used to identify the important frequencies, and transmissibility measurements across the mount.

WU, Chih, Professor, "Performance of a Solar Engine Driven Air Conditioning System," *International Journal of Ambient Energy*, v. 14, #2 (1993), 77-82.

Utilization of a solar-powered, low-temperature, Rankine cycle to operate a conventional mechanical compression air-conditioning cycle is capable of providing a cooling load. The aim of this paper is to use an endoreversible system approach for the analysis of the performance of such a solar-heat-engine-driven-air-conditioning system. The only irreversiblities are heat transfers due to finite temperature differences between the system and the three surrounding heat reservoirs.

WU, Chih, Professor, "Specific Heat Loading of an Endoreversible Carnot Heat Pump," *International Journal of Ambient Energy*, v. 14, #1, (1993), 25-28.

An endoreversible Carnot cycle is presented in this paper for a heat pump, where the specific heating load is limited by the power input. The endoreversible Carnot cycle is a modified Carnot cycle where the heat transferred between the heat pump and its surroundings is irreversible. A specific heating load is adopted as the objective function for the performance analysis of the heat pump. The relation between the maximum specific heating load and power input of the heat pump is found.

WU, Chih, Professor, "Heat Transfer Effect on the Specific Power Availability of Heat Engines," *Energy Conversion and Management, an International Journal*, v. 34, #12, (December 1993), 1239-1247.

The maximum possible specific power (specific power availability) that can be obtained from heat engines with a set of high temperature heat source and low temperature sink is analyzed. The heat engines considered in this paper include (1) externally and internally reversible, (2) externally irreversible and internally reversible, (3) externally reversible and internally irreversible and (4) externally and internally irreversible engines. The irreversibilities are assumed to be caused by heat transfer only. The specific power, defined as the power output per unit total heat exchanger surface area, is adopted as the objective function in determining power economics in this paper.

WU, Chih, Professor, "Analysis of an Endoreversible Stirling Cooler," *Energy Conversion and Management, an International Journal*, v. 34, #12, (December 1993),

1249-1253.

An internally reversible and externally irreversible Stirling refrigeration cycle which achieves cryogenic temperatures in a single stage is presented in this paper. The equations relating the maximum cooling load, working fluid temperatures, and power input of the cryocooler are found. These relationships provide a base for practicing engineers to design a new cryocooler.

WU, Chih, Professor, and David A. Blank, "Optimization of the Otto Cycle with Respect to Both Power and Mean Effective Pressure," *Energy Conversion and Management, an International Journal,* v. 34, #12,(December,1993), 1255-1259.

The output response of an endoreversible Otto cycle with combustion is optimized with respect to both power and mean effective pressure. The endoreversible cycle is one in which the heating process by combustion and the heat removing process to the surroundings are the only irreversible processes in the cycle. Expressions for these two responses are derived and optimized and a comparative analysis of results is conducted. This paper provides an additional criterion for use in the evaluation of the performance and the suitability of an Otto engine.

WU, Chih, Professor, "Analysis of an Endoreversible Rallis Cycle," *Energy Conversion and Management an International Journal,* v. 35, #1,(1994), 79-85.

An optimal performance analysis of an endoreversible Rallis cycle was carried out. The maximum power of the Rallis heat engine, the maximum heating load of the Rallis heat pump, and the maximum cooling load of the Rallis refrigerator for steady-state operation were obtained. The power, heating load and cooling load bounds of the Rallis cycle provide much more realistic prediction of performance characteristics than the traditional thermodynamic completely reversible model.

WU, Chih, Professor, "Specific Heat Loading of Thermoelectric heat Pumps," *Energy Conversion and Management an International Journal,* v. 35, #6,(1994), 459-464.

A mathematical model for calculating the performance of a thermo electric heat pump to achieve a specific heating load is presented. The effects of Joulean heating and thermal conduction are considered. An elaborate heat transfer model is employed to relate the thermal resistances between the thermoelectric system and its surroundings. A specific heating load, (heating load per

unit of total heat exchanger surface area), is adopted as the objective function for the thermoelectric heat pump performance analysis in this paper.

WU, Chih, Professor, "Simulation Analysis and Optimization of a Finite Time Gas Power Plant," *International Journal of Power and Energy Systems,* v. 13, #3, (1993), 73-77.

The power output of a simple, finite-time closed gas-turbine power plant is modeled and analyzed. The model adopted is a reversible Brayton cycle coupled to a heat source and a heat sink by heat transfer. Both the heat source and the heat sink may have either finite or infinite heat-capacity rates. A mathematical expression is derived for the power output of the irreversible power plant. The maximum power output of the power plant is found by computer simulation. The maximum bound provides the basis for designing a real closed gas-turbine power plant and for a performance comparison with existing power plants.

WU, Chih, Professor, and William H. Avery of Johns Hopkins U., *Renewable Energy From the Ocean; a Guide to OTEC,* Oxford University Press, (1994), textbook/reference book, 496 pp., 236 illustrations.

As scientists and engineers around the world strive to develop new sources of energy, one source--ocean thermal energy conversion (OTEC)--has aroused considerable interest due to its virtually unlimited potential. OTEC technology comprises of a number of cutting-edge techniques that produce fuel and electricity from solar energy generated heat. WIlliam H. Avery, widely regarded as the fields premier authority, here reviews the status and background of this promising technology, providing the only detailed presentation of basic OTEC technology and testing. Based on extensive development initiatives undertaken through international efforts, the book includes topics such as the workings of an OTEC power plant, how OTEC systems might be implemented as part of a futuristic national energy strategy, and assessments of OTEC economics as compared to other energy production methods. It will be of interest to a wide range of professionals and students in energy research, power engineering, and mechanical engineering.

WU, Chih, Professor, "Specific Power Analysis of Thermoelectric OTEC Plants", *Ocean Engineering,* v. 20, #4, (1993), 433-442,.

The specific power output of a real thermoelectric OTEC

plant is analyzed and optimized. The thermoelectric OTEC is treated as an external and internal irreversible heat engine. The irreversibilities of the heat engine are limited to the factors of heat transfers and Joulean loss only. The specific power output of the real thermoelectric OTEC is then compared with that of the Carnot OTEC, endoreversible OTEC, and external reversible thermoelectric OTEC.

WU, Chih, Professor, "Cooling Capacity Optimization of a Waste Heat Absorption Refrigeration Cycle," *Heat Recovery Systems and CHP*, v. 13, #2, (1993), 161-166.

A finite-time endoreversible heat-driven absorption refrigerator is modeled thermodynamically in this paper. The refrigerator uses low-temperature waste heat directly to provide a cooling effect. The maximum cooling capacity delivered by the absorption is analyzed.

WU, Chih, Professor, (co-author) "A First Order Simulation Model For Shipboard Absorption Chillers and Heat Pumps," International Journal of Power and Energy Systems, v. 14, #1,(1994), 1-4.

A first-order model for a shipboard absorption chiller and heat pump is developed to simulate various absorption cycle configurations for different working fluids. The computer model has separate subroutines for each of the major units of the chiller. The fluid property data is contained in separate subroutines to allow easy addition of other working fluids. The connections between the unit subroutines for a specified configuration yield a system of nonlinear simultaneous equations that are solved by a set of general equation-solving subroutines.

WU, Chih, Professor, "A Computer Code for the Power Analysis of a Finite Time Gas Power Plant," *International Journal of Microcomputer Applications*, v. 12, #2, (1993), 61 - 67.

The power output of a simple, finite-time closed gas-turbine power plant is modeled and analyzed. The model adopted is a reversible Brayton cycle coupled to a heat source and a heat sink by heat transfer. Both the heat source and the heat sink may have either finite or infinite hear-capacity rates. A mathematical expression is derived for the power output of the irreversible power plant. The maximum power output of the power plant is found by computer simulation. The maximum bound provides the basis for designing a real closed gas-turbine power plant and for a performance comparison with existing power plants.

WU, Chih, Professor, with V. J. Lopardo, R. L. Kiang and G. N. Karpouzian, "Finite-Time Thermodynamics and Endoreversible Heat Engines," *Journal of Mechanical Engineering Education*, v. 21, #4, (1993), 337-346.

An endoreversible heat engine is an internally reversible and externally irreversible cyclic device which exchanges heat and power with its surroundings. Classical engineering thermodynamics is based on the concept of equilibrium. Time is not considered in the energy interactions between the heat engine and its environment. On the other hand, although rate of energy transfer is taught in heat transfer, the course does not cover heat engines. The finite-time thermodynamics is a newly developing field to fill in the gap between thermodynamics and heat transfer. Two types of engines are modelled in this paper--a reciprocation and a steady flow--with results obtained for maximum power output and efficiency at maximum power. It is shown that the latter is the same for both types of engines but that the maximum value of power production is different.

WU, Chih, Professor, and R. M. Adams, "Nuclear Power Gas Turbines: an Old Idea Whose Time Has Come," *International Journal of Power and Energy System*, v. 13, #2, (1993), 33-39.

It is possible, by combining proven technologies to produce a closed-cycle gas turbine engine in which the gas is heated by a nuclear reactor. The characteristics of the engine would include rapid start capabilities, rapid response to changing load conditions, independence from fuel supply uncertainties, small total plant volume, independence from oxygen, zero air pollution, relatively low thermal pollution, a high level of plant safety, relative ease of maintenance and operation, reduced long term radioactive waste, and acceptable lifetime cost.

WU, Chih, Professor, and D. A. Blank, "The Effect of Combustion on a Power Optimized Endoreversible Diesel Cycle," *Energy Conversion and Management, an International Journal*, v. 34, #6,(1993), 493-498.

The power potential of an endoreversible Diesel cycle with combustion is analyzed and optimized. The endoreversible cycle is one in which the heating process by combustion and the heat removing process to the surroundings are the only irreversible processes in the cycle. A mathematical expression is derived and optimized for the power output of the cycle. This paper provides another criterion besides thermal efficiency, mean effective pressure and detonation for use in the

evaluation of the performance and the suitability of a diesel engine.

WU, Chih, Professor, "Maximum Cooling Load of a Heat-Engine-Driven Refrigerator," *Energy Conversion and Management, an International Journal,* v. 34, #8, (1993), 691-696.

An endoreversible heat-engine-driven refrigerator system designed to carry out the conversion of a high-temperature heat transfer into a cooling effect is modeled thermodynamically in this paper. The endoreversible system couples an external irreversible and internal reversible Carnot heat engine with a work-driven external irreversible and internal reversible Carnot refrigerator. The maximum cooling load of such a combined device is analyzed.

WU, Chih, Professor, "Simulation Analysis and Optimization of a Finite-Time Gas Power Plant," In*ternational Journal of Power and Energy System,* v. 13, #3, (1993), 73-79.

The power output of a simple, finite-time closed gas-turbine power plant is modeled and analyzed. The model adopted is a reversible Brayton cycle coupled to a heat source and a heat sink by heat transfer. Both the heat source and the heat sink may have either finite or infinite heat-capacity rates. A mathematical expression is derived for the power output of the irreversible power plant. The maximum power output of the power plant is found by computer simulation. The maximum bound provides the basis for designing a real closed gas-turbine

power plant and for a performance comparison with existing power plants.

WU, Chih, B. Hwang, F.C. Chen, N. Domingo, R.W. Murphy , "Review of Steam Production From Engine Waste and its Feasible Shipboard Application," *International Journal of Power and Energy Systems,* 14, 2, (1994), 49-53.

This paper is a survey of the major components in land-based engine waste-heat recovery systems and their operating experiences. Steam-generation systems using a pressurized-water flashing process and steam compression are employed by several of the surveyed cogeneration facilities and are feasible for shipboard applications.

WU, Chih, and R.L. Kiang, "Clarification of Finite-Time Thermodynamic-Cycle Analysis," *International Journal of Power and Energy Systems,* 14,2, (1994), 68-71,.

The power output of an endoreversible Carnot engine is finite, and it can be maximized in terms of its operating temperature limits. The literature contains two different expressions for the maximum power. A careful examination of the analysis leading to these two power expressions shows that on one approach, the Carnot engine is treated as a reciprocating engine. The maximum power obtained from this approach is identical to that derived by Curzon and Ahlborn. On a second approach, the Carnot engine is treated as a steady-flow engine. This subtle difference has not been emphasized by any of the authors cited in the references, and we intend in this paper to clarify this apparent ambiguity.

Presentations

BARTON, Jr., O., and Reiss, R., "Bucking Analysis of Symmetric Laminated Plates Determined by Eigensensitivity Analysis", 35th AIAA/ASME/ASCE/AHS/ASC Structures, Structures Dynamics and Material Conference, Hilton Head, South Carolina, April 18-21, 1994.

BARTON, Jr., O., and Reiss, R., "Vibration of Antisymmetric Laminated Plates Using Eigensensitivity Analysis", The Second International Conference on Computational Structures Technology, Athens, Greece, August 30-September 1, 1994.

MECHANICAL ENGINEERING

DAVIS, G. W., HODGES, G. L., and MADEKA, F. C., "The Development of a Series Hybrid Electric Vehicle for Near-Term Applications", 28th Intersociety Energy Conversion Engineering Conference, Atlanta, GA, August 8, 1993.

DAVIS, G. W., HODGES, G. L., and MADEKA, F. C., "The Development and Performance of the AMPhibian Hybrid Electric Vehicle", 1994 SAE International Congress and Exposition, 28 February, 1994.

MADEKA, F. C., DAVIS, G. W., and HODGES, G. L., "The Selection of Lead-Acid Batteries for use in Hybrid Electric Vehicles", 1994 SAE International Congress and Exposition, February 28, 1994.

FLACK, Karen A., Assistant Professor, "Near-Wall Mean Flow Results for a Three-Dimensional Turbulent Boundary Layer," The American Physical Society 46th Annual Meeting of the Division of Fluid Dynamics, Albuquerque, New Mexico, 20-23 November 1993.

FLACK, Karen A., Assistant Professor, "Near-Wall Flow in a Three-Dimensional Turbulent Boundary Layer on the Endwall of a Rectangular Bend," AIAA 32nd Aerospace Sciences Meeting, Reno, Nevada, 10-13 January, 1994.

FLACK, Karen A., Assistant Professor, "Near-Wall Investigation of Three-Dimensional Turbulent Boundary Layers," Seminar at VPI & SU, Aerospace and Ocean Engineering Department, Blacksburg, Virginia, 24 March, 1994.

HASSON, Dennis F., Professor, and M. K. Hamm, "The Effect of Temperature on the Impact Behavior of TiB_2 Reinforced XD™-TiAl Intermetallic-Matrix Composites", International Conference on Mechanisms and Mechanics of Composites Fracture, Pittsburg, Pennsylvania, 18 October 1993.

HASSON, Dennis F., Professor, and L. A. Gish, "Effect of Exposure to High Temperature Air on the Impact Behavior of Uncoated and Fluoromica Coated Nicalon Fiber Glass-Ceramic Composites", International Conference on Mechanisms and Mechanics of Composites Fracture, Pittsburg, Pennsylvania, 20 October 1993.

JOYCE, James A., Professor, "Improved Load Ratio Method for Prediction of Crack Length", Symposium on Special Applications for Advanced Techniques for Crack Size Determination, ASTM, Atlanta, Georgia, June 1993.

JOYCE, James A., Professor, "Modifications of E813-89 Proposed for Reballot", Committee E08.08.03, ASTM, Committee Week, Atlanta, GA, June 1993.

JOYCE, James A., Professor, and Link, R. E., "Experimental Investigation of Fracture Toughness Scaling Models", Symposium on Constraint Effects in Fracture, ASTM, Fort Worth, Texas, November 1993.

JOYCE, James A., Professor, "Advances in J-R Curve Testing", JCCNRS Working Group 3, Rockville, Maryland, 27 October 1993.

JOYCE, James A., Professor, "Upper Shelf JFC-Q and Tmat-Q Locus Results for Structural Steels", NRC Constraint Workshop, Annapolis, Maryland, 21 April 1994.

MADEKA, Frank C., Major, USAF, Greg W. DAVIS and LCDR Gary HODGES, USN, LOPARDO, V. J., Professor, "Engineering Education: Future Directions," USNA, December 1993.

MINER, Steven M., Assistant Professor, "Fundamentals of Fluid Mechanics," Computational Fluid Mechanics Using Finite Elements, short course at U. of Maryland, 10-12 November, 1993.

MINER, Steven M., Assistant Professor, "Fluid/Structure Interactions in Composite Panels", ASME/ASCE/SES Joint Technical Meeting, Charlottesville, Virginia, 6-9 June, 1993.

MINER, Steven M., Assistant Professor, "Computational and Experimental Investigation of the Pressures and Velocities in a Single Volute Centrifugal Pump", ROCON '93 Conference, 10-12 November, 1993.

MORAN, Angela L., Assistant Professor, "Spray Forming of High Strength, Lightweight Alloys and Composites" with A.Leatham, the 40th Sagamore Conference, Massachusetts, August 1993.

MORAN, Angela L., Assistant Professor, "Industrialization and Certification of Large Diameter Spray Formed Superalloy Components for Military Applications," International Conference on Spray Forming, United Kingdom, September 1993.

MECHANICAL ENGINEERING

MORAN, Angela L., Assistant Professor,High Deposition Rate Spray Forming for Military Applications" with R. Rebis, C. Madden and R. Payne, First International Conference on Processing Materials for Properties, Hawaii, November 1993.

MORAN, Angela L., Assistant Professor,"An Approach to Modelling the Spray Forming Process with Artificial Neural Networks" with M. Matteson, R. Payne and C. Madden, International Conference on Spray Forming, United Kingdom, September 1993.

MORAN, Patrick J., Associate Professor, "Production of Stainless Aluminum Alloys by Spray Forming Methods", ONR Contractor's Review Meeting, Martin Marietta Laboratories, Baltimore, Maryland, January 1994.

MORAN, Patrick J., Associate Professor, "Methodology to Study the Atmospheric Degradation of Organic Coatings via Electrochemical Impedance Spectroscopy", Quantitative Methods for Evaluation of Paint Coating Performance Workshop, Naval Surface Warfare Center, Annapolis, Maryland, 27-28 October, 1993.

MORAN, Patrick J., Associate Professor, co-author, "Crevice Corrosion of a Nickel-Based Superalloy in Natural and Chlorinated Seawater", 12th International Corrosion Congress, Houston, Texas, 19-24 September, 1993.

MORAN, Patrick J., Associate Professor, co-author, "The Passivity of Carbon Steel in Organic Solutions", 12th International Corrosion Congress, Houston, Texas, 19-24 September, 1993.

RAOUF, Raouf A., Assistant Professor, "Effects of Manufacturing Imperfections on Interlaminar Stresses in Thick Composite Plates," American Society of Composites 8th Technical Conference on Composite Materials, Cleveland, OH, 19-21 October 1993

RAOUF, Raouf A., Assistant Professor, "Dynamics of Laminated Plates With Layer Waviness," SPACE94 Conference, New Mexico, 26 Feb - 1 March 1994.

RATCLIFFE, Colin, Assistant Professor USNA;

Armando L. Santiago and Roger M. Crane of NSWC, "Composite Cylinder Cross Section Tailoring for Radiated Noise Reduction", Denver, Colorado, 5-8 October, 1993.

RATCLIFFE, Colin, Assistant Professor USNA, with Armando L. Santiago and Roger M. Crane of NSWC, "Flexible Composites: Material and Structural Damping Experimental Characterization", ASM/TMS Material Exposition, Pittsburg, Pennsylvania, 18-21 October 1993.

RATCLIFFE, Colin, Assistant Professor, Armando L. Santiago, Roger M. Crane and Robert K. Garrett Jr, "Noise Reduction of Underwater Cylindrical Structures", EW-01-94, NSWC, January 1994.

RATCLIFFE, Colin, Assistant Professor, with R. M. Crane and A. L. Santiago, "Structural and Damping Characteristics of a Flexible Composite Structure", Int'l Symposium on Materials for Noise and Vibration Control, 1994 ASME Annual Meeting, Chicago Illinios.

WU, C., and DAVIS, G. W., "Performance of a Geothermal-Heat-Engine-Driven-Air-Conditioning System", International Conference on New Energy Systems and Conversions, Yokohama, Japan, 27 June, 1993.

WU, Chih, Professor, "Performance of a Geothermal Heat Engine Driven air Conditioning System," First International Conference on New Energy Systems and Conversions, Yokohama, Japan, 27-30 June, 1993.

WU, Chih, Professor, "Engineering Systems for Mixed Nuclear Waste," 9th International Conference on Systems Engineering, Las Vegas, Nevada, 14-16 July, 1993.

WU, Chih, Professor, "Finite-Time Thermodynamic Optimization of Solar Heat Engines," ISES Solar World Congress, Budapest, Hungary, 23-27 August , 1993.

WU, Chih, Professor, "The Future Engineering Education in the Republic of China," 1993 CAPA (Chinese American of Professional Association) Conference, Washington, D.C., 12-15 November, 1993.

Naval Architecture, Ocean, and Marine Engineering

Professor Marshall L. Nuckols
Chair

The Naval Architecture, Ocean, and Marine Engineering Department conducted scholarly research and professional development rigorously in all three disciplines of this department during the academic year 1993-1994. Faculty members and midshipmen took part in numerous sponsored research activities, including the Trident Scholar Program. A number of faculty members participated in non-funded research and directed senior midshipmen in their research activities, utilizing the excellent laboratory and computer facilities available to this department.

The department continued to participate actively in professional society meetings and conferences, both nationally and internationally. Research results have been published in journals and other technical publications or presented at national or international seminars. The outcome of the department's deep involvement in research by the civilian and military faculty members is reflected by the academic environment in the classroom for professional and major courses.

Research themes of the department faculty were varied. They include investigations of air classifier technology, radiation dosimeters, helium injection in the bedwater of a steam turbine, thermal performance of Non-chlorofluorocarbon (CFC) refrigerants, venture compressor design, noise level inside a diving helmet, structural stability of tee-stiffened panels, wave and current loading of ocean structures and beaches, motion of moored ships, ship motions in wind and waves, reliability centered, and computer aided hydrodynamic design.

Research funding was made available from many sources, including department operating funds, research chairs, and contracts and grants from various research organizations such as the Department of Energy, Office of Naval Research, Navy Surface Warfare Center, Naval Sea Systems Command, U.S. Coast Guard, National Science Foundation, Mobil Research and Development Corporation, U.S. Army Corps of Engineers, Naval Facilities Engineering Command, Coastal Systems Station, Panama City, Florida, and the Trident Scholar Program.

Sponsored Research

Evaluation of Air Classifier Technology for Removal of Heavy Metals from Soils

Researchers: Midshipmen 1/C Paul Algoso,
Heath Henshaw, Aaron Miles, Marc Genualdi, USN,
and Professor Martin E. Nelson
Sponsor: Department of Energy

A theoretical and experimental analysis of the applicability of air classification utilizing centrifugal and elutriation principles was conducted. This research was performed at the United States Naval Academy with specific experimentation on two commercially available mechanical separators. The first, a centrifugal air classifier, was obtained from the Sepor Corporation, and the second, an elutriation type separator supplied by the Ducon Company.

Air classification systems produce two effluent

streams which can be referred to as the fine and coarse fractions. Success can be achieved if the heavy metal can be concentrated in either stream. The initial project goal was to concentrate eighty percent of the heavy metal in twenty percent of the soil. Air classification of the heavy metal depends on the density difference between the soil and heavy metal as well the particle size distribution of

the soil and heavy metals. Results approaching the project goal were achieved by sieving the fine and coarse effluent streams. These results indicate that air classifier technology can be successfully employed in environmental restoration alone or as part of a multi-step process.

Evaluation of Temperature Compensated Bubble Dosimeters for Treaty Verification Applications

Researcher: Midshipman 1/C Class Brad Baker, USN
Sponsor: Trident Scholar Program

Due to the drawdown of nuclear weapons through treaties between countries and the possible proliferation of nuclear weapons to the Third World, the Defense Nuclear Agency is investigating different methods that can be used to distinguish nuclear from non-nuclear munitions. Due to its small size, location of electronics, and non-obtrusive data collection capability, the bubble dosimeter is a candidate for this process.

The objective of this research is to investigate the response of alternate droplet material bubble dosimeters as it pertains to arms control verification procedures. This was accomplished by theoretically and

experimentally studying (1) the bubble dosimeter's response to warhead neutron intensity and energy, (2) the bubble dosimeter's sensitivity to gamma radiation, (3) the bubble dosimeter's response as a function of temperature, and (4) the bubble dosimeter's response as a function of neutron energy.

Conclusions are made regarding the potential use of bubble dosimeter for treaty verification applications. Through research on simulated warhead sources, practical procedures are outlined for using the bubble dosimeter to distinguish nuclear from non-nuclear munitions.

An Investigation of the Effect of Helium Injection on a Rankine Plant

Researchers: Assistant Professor Martin R. Cerza,
Professor Peter F. Wiggins, and
Lieutenant Commander Thomas E. O'Loughlin, USN
Sponsor: Chief of Naval Operations (N091)

The purpose of this investigation was to determine if the injection of helium into the feedwater system of a typical Rankine Cycle power plant would increase the total work output from the turbines and increase the cycle thermal efficiency. The helium was injected into an "open" system, that is, the helium would flow once through the cycle and not be reclaimed but the primary working fluid would be. The Rankine Cycle power plant utilized was the Steam Power Plant of the US Naval Academy's Marine Propulsion Laboratory. The plant was capable of delivering steam to the turbine throttle valve at 250 psig, 500°F into an operating condenser where pressures can

be as low as 0.5 psia. The main steam flow rate was held constant at 2350 lbm/hr. The plant was retrofitted to inject a small amount of helium gas into the feedwater system on the discharge side of the feedwater pump, after the feedwater control valve, and before the steam drum in the oil fired boiler. The helium flow rate was varied in this study from 0.8 to 2.0 lbm/hr (77 to 194 Standard Cubic Feet per Hour) which corresponded to helium/steam mass ratios of 0.0348 to 0.0870%, respectively. Results indicated that with helium modified steam, the overall plant efficiency rose by 2% over the standard (unmodified) steam case.

Boiling and Condensation Thermal Performance for Non-CFC Refrigerants with and without Enhanced Heat Transfer Surfaces

Researcher: Assistant Professor Martin R. Cerza
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

An International agreement in 1992 called the Montreal Protocol has set the stage for the phasing out of Ozone harmful refrigerants, CFC's (ChloroFluoroCarbons) and has established guidelines for phasing in HFC's (HydroFluoroCarbons) which are Ozone safe. In its efforts to comply with the Montreal Protocol, the US Navy will be redesigning its shipboard refrigeration facilities. This means that phenomena associated with the thermal performance of refrigeration facilities, namely, boiling and condensation heat transfer will have to be examined with regard to the new HFC refrigerants. In addition, in order to make the new equipment lighter and more compact, enhanced heat transfer surfaces are also being developed. These new surfaces show great promise for enhancing heat transfer on boiling and condensation surfaces. This investigation studies the phenomena involved with new HFC refrigerants on existing and enhanced boiling and condensation heat transfer surfaces.

Venturi Compressor Design for Injecting Helium into the Rankine Cycle

Researchers: Midshipman 1/C Harold W. DuBois, USN,
Assistant Professor Martin R. Cerza
and Associate Professor Kenneth L. Tuttle
Sponsor: Chief of Naval Operations (N091)

The venturi compressor design is used for the injection of helium into the feedwater line of a steam power plant. The eductor will use high pressure water to compress helium gas. This project will test the hypothesis that the eductor design will eliminate the future use of an efficiency limiting pump. Bernoulli's equation will be the basis for the investigation. The equations generated will develop the theory and characterize the design performance. A prototype venturi compressor will experimentally demonstrate the principles involved and generate design data.

Low Frequency Operating Noise Comparison of the U.S. Navy MK21 and MK12 Diver Helmets

Researchers: Midshipman 1/C Robert T. Graffum, III, USN,
and Professor Marshall L. Nuckols
Sponsor: Naval Sea Systems Command

Little is known about the potential hazards of noise on diver's hearing in hyperbaric environments. Recent studies have concentrated on determining the noise levels experienced by divers and the effects of pressure on their sensitivity to this noise. These studies are of particular interest to the U.S. Navy dive community in order to determine permissible exposure limits of divers.

The Mk 21 Dive Helmet is one system currently being studied. Mk 21 is overly noisy. This project was aimed at determining the breathing noise levels of the Mk 21 helmet at varying respiratory rates and ambient pressures. Using the Mk 21 Surface Supplied diving System, the workhorse helmet of the fleet, as the standard, a baseline of low frequency breathing noise is established for comparing the Mk 21. Testing was conducted at the U.S. Naval Academy's Life Support Laboratory using a breathing simulator and 1000 psi pressure vessel.

An Experimental Investigation into the Structural Stability of Tee-Stiffened Plate Panels Under Combined Loads

Researcher: Professor Gregory J. White
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This investigation will attempt to provide analytical, design and experimental test support for an investigation into the structural stability of tee-stiffened plate panels subjected to in-plane compressive axial load and lateral pressure load using the test facilities at the U.S. Naval Academy.

Analytical and design support will be required to assist in defining the geometry of specimens to rest as well as the combination of in-plane axial and lateral pressure loads to apply. This support entails overseeing the tests to be conducted at the Naval Academy and acquisition of test data.

Wave Transformation Measurements from SUPERTANK

Researcher: Associate Professor David L. Kriebel
Sponsor: National Science Foundation

The SUPERTANK Data Collection Project, sponsored by the Army Corps of Engineers, was conducted during August and September 1991 at the Wave Research Laboratory of Oregon State University. The goal of the project was to collect data on nearshore waves and sediment transport under controlled conditions at prototype scale in a large wave tank. Over 30 investigators from the U.S. and several other countries took part in this project. The goal of this research was to measure wave conditions in the so-called swash zone between the still water shoreline to the upper limit of wave runup. Preliminary data analysis has been completed and a report has been published by the Army Corps of Engineers.

Wave-Current Loading on a Production Caisson

Researcher: Associate Professor David L. Kriebel
Sponsors: Mobil Research and Development Corporation
and National Science Foundation

An experimental investigation was conducted to document extreme loading on a vertical production caisson (30-inch diameter steel pile containing a producing oil well) in waves and currents with depth-limited breaking waves. This work was motivated by recent failures of these structures during Hurricane Andrew in the Gulf of Mexico. In addition, there are continued uncertainties in the way wave-current interactions are treated in wave force calculations as recommended by the American Petroleum Institute. Several sets of laboratory experiments were conducted in a large wave tank in order to provide design guidance. Tests are conducted at a 1-to-20 scale with a single vertical cylinder instrumented to measure in-line and transverse forces and overturning moments. Tests simulate "shallow water" Gulf of Mexico conditions with a full-scale water depth of 50 feet and with wave heights of up to 40 feet.

Wave Runup on Composite-Slope and Concave Beaches

Researchers: Associate Professor David L. Kriebel
and Associate Professor Robert H. Mayer
Sponsor: U.S. Army Corps of Engineers

This project involved laboratory testing of wave runup on curvilinear beaches in order to evaluate a new theory for the prediction of runup on the open coast. Wave runup is defined as the vertical rise of the water surface above the still water level associated with the final transfer of kinetic to potential energy as the wave reaches a sloping beach. Runup is important because it determines the uppermost limit of wave-induced sediment transport and the landward limit of wave interaction with ocean-front structures. A problem with existing predictive methods for runup, however, is that they are difficult to apply on open-coast beaches due to the complicated geometry of natural beaches. The goal of this study was to evaluate a new predictive formula that can be easily applied to realistic beach geometries.

Experimental testing involved 20 combinations of wave height and period, along with 6 different combinations of water level and beach-face slope. In each of these 120 tests, wave runup was measured along with incident wave conditions. These measured runup values were then compared to values predicted by the new theoretical model. In general, the new method was found to be highly effective at describing the wave runup for these complicated but realistic curvilinear beaches.

Theoretical Analysis of Air Classifiers Used to Remove Heavy Metals from Soil

Researcher: Associate Professor Keith W. Lindler
Sponsor: Department of Energy

Extensive nuclear testing that has been conducted at the Nevada Test Site, other Department of Energy (DOE) sites, and many Naval Facilities Engineering Command (NAFAC) sites has left heavy metal radioactive contaminants such as Plutonium in the soil. Environmental restoration efforts have been initiated to purify the contaminated areas. The current effort by DOE involves many different approaches including physical, chemical and biological separation.

The United States Naval Academy is conducting tests of physical separation methods. Two bench scale models of physical separation systems (air classifiers) currently used in industry for dust, gravel, and petroleum product separation are being studied and tested at the Naval Academy in order to determine their ability to remove heavy metals from soil. Since the Naval Academy is not licensed to handle radioactive soil, it is using non-contaminated soil from the Nevada test site that has been artificially contaminated with Bismuth. The physical properties of the Bismuth are similar to the Plutonium so that a separator that is successful with the surrogate soil should be successful with the radioactive soil.

The project goal is to remove 80% or more of the Plutonium with 20% or less (by volume) of the soil. Spreadsheet calculations indicate that air classifiers in conjunction with sieves can exceed the project goals.

Nonlinear Motions of Moored Ships

Researcher: Assistant Professor Sarah E. Mouring
Sponsor: Naval Facilities Engineering Command

The problems caused by excessive motions of single point moored (SPM) ships are associated with the hawser configuration. These motions can cause the loading on a hawser to exceed the snap load; therefore, such motions are critical to the safety of the mooring. However, ship motions are difficult to predict due to the nonlinearity of the equations of motion. Recently, experimental and theoretical studies of the nonlinear motions of SPM supertankers have been performed by Wichers and de Kat. Since supertanker motions are relatively slow, many of the nonlinear terms in the hydrodynamic force equations were neglected. This assumption needs to be verified. Therefore, the purpose of this study was to determine the sensitivity of the nonlinear motions of a

ship to each one of these neglected higher order terms. The nonlinear equations of motion were developed by Professor Michael E. McCormick and Assistant Professor Sarah E. Mouring. These equations included all of the nonlinear terms. These modified equations have been simultaneously solved by developing a computer program using the computer language, Advanced Continuous Simulation Language (ACSL). The equations of motion were applied to both combatant and commercial ships using the computer program. Results show that there is a great level of sensitivity of the nonlinear motions to each neglected higher order term. Therefore, these higher order terms should not be neglected in the nonlinear analysis of ship motions.

An Experimental Analysis of the Motions of Two Coast Guard Cutter Models in Wind and Waves

Researchers: Professor Bruce C. Nehrling and
Professor Roger H. Compton
Sponsors: Naval Sea Systems Command and
United States Coast Guard

An experimental research program to investigate the stability characteristics and motions of frigate size ships was conducted at the United States Naval Academy's Hydromechanics Laboratory. This effort is one leg in a tripartite cooperative naval program of analytical performance predictions, physical model evaluations, and full scale ship trials. Three dimensional models of two coast Guard cutters were constructed and tested at selected headings while at zero speed in various sea states and wind conditions. Model results, which have been expanded to full scale values, are being compared by Naval Sea Systems Command to analytical predictions and by the Coast Guard to actual ship data taken this past January in the Gulf of Alaska. Work continues on this project with the eventual goal of providing both the ship designer and the ship operator better information for predicting a ship's stability and selecting appropriate criteria that the ship must be able to satisfy.

Bubble Dosimeter Suitability for Nuclear Arms Control

Researchers: Professor Martin E. Nelson, Assistant
Professor Mark J. Harper, and Ensign Jeremy Rich, USN
Sponsor: Defense Nuclear Agency

The objective of this project was to investigate the feasibility of using the bubble dosimeter as an alternative to the present methods used to verify nuclear arms treaties. Because of the draw-downs of nuclear forces associated with the end of the Cold War, demand has increased for an unobtrusive technology that could be used in the field by inspectors to aid in determining whether the nuclear weapons inspected meet the guidelines of the treaties.

Although the bubble dosimeter is a rugged device ideally suited for field work, three problems must be solved before use of the dosimeter can be considered feasible. This project focused on evaluating and solving the problems of temperature dependence, bubble growth rate and accurate statistical analysis of the data. Extensive theoretical and experimental work was undertaken to design new detectors that would have a response which remained constant with temperature. Furthermore, extensive experimentation was conducted at the United States Naval Academy's Neutron Generator Facility, with the purpose of evaluating the neutron detection characteristics of the bubble dosimeter.

Analysis of Thermal Protection Systems
for Explosive Ordinance Disposal (EOD) Divers

Researcher: Professor Marshall L. Nuckols
Sponsor: Naval Surface Warfare Center, Panama City, Florida .

As part of the Memorandum-of-Understanding between USNA and the Coastal Systems Station (CSS), a thermal analysis of active and passive protection systems was conducted. Power requirements, thermal efficiencies, and characteristics of various active heating systems were evaluated and compared with an existing thermo-electric heat pump system (DATPS) presently under development for Special Warfare.

The mission requirements established for this analysis called for a small, light-weight heating system that could be deployed from a small craft such as an inflatable boat or a small Whaler. The system needed to be capable of providing adequate heating for two divers in 34 °F water for up to 6 hours during a decompression phase of the mission. A hybrid thermal protection method using waste heat from a surface-mounted outboard motor was proposed to create a warm "micro-climate" environment for divers. Closed-circuit and open-circuit options of this diver decompression shelter concept were evaluated.

Reliability Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle
Sponsor: Naval Sea Systems Command, Surface Ship

The purpose of this research is to develop faculty expertise and a Maintenance Engineering Laboratory at the U.S. Naval Academy for instruction of the midshipmen in modern maintenance engineering concepts. The objectives are to develop instructional capabilities in maintenance engineering, to introduce Reliability Centered Maintenance (RCM), to naval officers, and to develop long range planning for introducing maintenance engineering into the curriculum.

The Diesel Engine Room Laboratory was upgraded to allow operation of the Diesel Engine Monitoring and Analysis (DEMA) System on the GM 3-71 Diesel Engine/Generator Set using a Personal Computer. The computer which controls data acquisition, monitors alarm conditions, makes log sheets, maintains trend analyses and offers some expert system capability, at one time had a unique operating system and communication was difficult. The new Personal Computer Interface has made a dramatic improvement in the quality of the instruction being given the midshipmen using the DEMA System. Progress is being made toward the addition of significant new engine monitoring capabilities. A replacement head is being modified to allow measurement of cylinder firing pressures. The Naval Academy has joined the local developer of The DEMA System in developing further Diesel engine monitoring and analysis technology for the U.S. Navy. A slide show presentation is being developed for use in instructing the midshipmen on modern maintenance concepts such as Reliability Centered Maintenance.

Independent Research

Synthesis in Computer Aided Hydrodynamic Design

Researcher: Associate Professor Thomas J. Langan

This is an on-going research project to develop methods for synthesizing surfaces in computer aided hydrodynamic design. The approach applies known mathematical and computer techniques to develop computer methods for synthesizing hydrodynamic surfaces as opposed to simply using the computer to analyze the flow over a surface. At present several general methods have been identified and applied to several examples.

Non-Air-Breathing Diesel Submarine Engines

Researcher: Lieutenant Commander J. Gary Hawley, RN

Since its original conception in 1901, Various forms of non-air-breathing diesel submarine engine systems have been proposed, designed and developed to various degrees of technological advancement. In the majority of cases, the development emphasis has been focused towards its use onboard manned military vessels for the enhancement of underwater endurance over that possible with secondary batteries. This paper presents an account of the historical development of the non-air-breathing diesel submarine engine from its early conception through to the present day.

Research Course Projects

Fission Product Detection in the Kara Sea

Researcher: Midshipman 1/C K. B. Wilson, USN
Advisers: Professor Martin E. Nelson and
Assistant Professor Mark J. Harper

The purpose of this project was to investigate the usefulness of fission product detection in seawater using a liquid scintillation counting technique. The main advantage of liquid scintillation counting is the easy sample preparation requirements compared to other established measurement techniques.

The project has evaluated the effects of sample color, isotope concentration, spectroscopy or net sample count rates, and lower limits of detection. The isotopes evaluated included Cs-137, Sr-90 and Pb-210 using a Packard 2250 liquid scintillation counter.

The results indicate that detection levels of 10 pCi/1 can be made in the United States Naval Academy system, although counting times of 5 days would be required. Ultimately, the study wants to be able to count fission product radioactivity in seawater samples and apply it to area such as a dumped nuclear core in the Kara Sea. The study estimated that such concentration levels would be high near a site which contained a single spent core, which had leaked only 1% of its fission product inventory.

Ducon Entrainment Testing

Researcher: Midshipman 1/C Paul R. Algoso, USN
Adviser: Professor Martin E. Nelson

A difficult task of radioactive waste cleanup is the removal of contaminants mixed with soils at various Department of Energy and Naval waste sites. Since the disposal costs are proportional to the volume that is removed from a site, techniques that can concentrate the contaminant are under consideration.

Currently, the United States Naval Academy is investigating the air classifier process in order to determine its effectiveness in concentrating radionuclides mixed with soil. The air classifier investigated in this project was built by Ducon and is based on entrainment and elutriation principles. The Ducon system uses air flow to separate particles into two streams based on particle size and density.

In the Ducon system, soil is fed into a large separating chamber, where air flow is directed upward. Particles with a terminal velocity lower than the air flow velocity will move upwards and out of the chamber's top, while particles with a terminal velocity higher than the air flow velocity will continue falling to the bottom of the chamber where they can be collected.

This study investigated the effect of air velocity, feed rate, and soil dispersion within the chamber on mass fractions produced in the two effluent streams as well as the concentration of the contaminate in both streams. For testing purposes, soil mixed with Bismuth was obtained from the Nevada test site.

The results indicate that no significant amount of

soil can be sent into the fine effluent. The system's current configuration is not useful in site cleanup.

Damping Characteristics of Single Point Moored Ships Subjected to a Current

Researcher: Midshipman 1/C Bradley J. Andros, USN
Adviser: Assistant Professor Sarah E. Mouring

The influence of the currents on single point moored (SPM) ships can cause low frequency fish-tailing motions. These motions can cause large tensions in the mooring lines. In the past, moorings have failed when the forces applied exceeded the snap load. Currently, there is no method to accurately determine ship motions and the associated snap load of a ship moored in a current.

The present study is devoted to the determination of the effects of mooring lengths on the damping of the ship motions. A FFG-7 model was towed at speeds corresponding to prototype speeds of one, two, three, four, and five knots. The model was connected to the towing carriage by aluminum rods of two, three, and four feet in length. Measurements of the angle between the rod and the carriage, and the rod and the centerline of the ship were made by two potentiometers. These measurements were analyzed to determine the sway as a function of time in a dimensionless form. From these graphs, the damping effects can clearly be observed. The damping ratios are acquired using the log-decrement method. From the results of this study, both the stable and unstable conditions of a SPM ship were determined.

Model Study of a Compliant Offshore Tower

Researcher: Midshipman 1/C Michael Bosshard, USN
Advisers: Associate Professor David L. Kriebel and
Professor Thomas H. Dawson

Compliant towers are fixed ocean structures proposed for oil recovery in water depths ranging from 1500 to 3000 feet. They are slender and extremely flexible so that their natural periods of oscillation are three to four times the typical wave period. As a result, wave forces are never in phase with the tower's inertia and deck deflections are minimized.

Laboratory tests were carried out in the large wave tank at the U.S. Naval Academy to evaluate the response of a deep water compliant tower proposed by Shell Development Company. The prototype tower, with a height of 1600 feet, was simulated at a 1-to-100 scale ratio in the 16-foot deep wave tank. Gulf of Mexico design wave conditions, having a full-scale wave height of 70 feet and a wave period of 13 seconds, were scaled according to Froude modelling laws. The laboratory tests then consisted of three components: (1) determination of the natural period of the model, (2) determination of the dynamic structure motions in regular waves at 17 wave frequencies, and (3) determination of the dynamic structure motions in random waves using both Pierson-Moskowitz and Joint North Sea Wave Project (JONSWAP) wave spectra. Data acquisition for deck motions was accomplished with the Expert Vision video tracking system.

The data collected shows that compliant towers are well suited for controlling deck deflection in their operating regimes. Additionally, the model, contrary to the erratic behavior that was expected because of this low stiffness, exhibited deflections predominantly in the direction of wave propagation with little or no transverse or torsional motion.

Structural Stability of Tee-Stiffened Panels

Researcher: Midshipman 1/C Laura A. Herath, USN
Adviser: Professor Gregory J. White

The most common structural element in Naval ships is the tee-stiffened panel. Most design procedures look at these panels under one set of simplified loading conditions and then add factors of safety. This procedure has worked reasonably well for the heavily-built ships of the past. However, as new materials and technologies are introduced the weight of the ship's structure becomes lighter, and as a result, a more thorough understanding of

what happens to these panels under combined loadings is needed.

In this project the most widely accepted analytical model for the evaluation of stiffened panels was investigated. The results of the model were compared to all of the physical testing results available in the literature. The model was also compared to the results of the first structural test performed in the United States Naval Academy Ship Structures Laboratory grillage test fixture. For most cases the analytical model was able to predict the failure load within about 10-percent.

However, for cases with large out-of-plane loads in addition to the in-plane loads, the model produced failure stresses which were excessively low. While this gives a safe structure, it indicates that the model may not be adequate for use in reliability-based structural design.

The project also investigated the reasons for the model's inability to correctly predict the failure stress under combined loads. Using the results from the U.S. Naval Academy tests, it was found that the model does not correctly account for the plate stiffness contribution to the panel buckling.

Venturi Compressor Design for Injecting Helium into the Rankine Cycle

Researcher: Midshipman 1/C Harold W. DuBois, USN
Advisers: Assistant Professor Martin R. Cerza and
Associate Professor Kenneth L. Tuttle

This research investigated whether or not ambient gas (air) at atmospheric pressure could be compressed hydraulically by drawing it into the throat of a venturi flow device and allowing the liquid recovery pressure in the diffuser section to compress the gas. If a device like this could work, there would be a remarkable reduction in the compression power required for a venturi hydraulic compressor. This compressor pumps a liquid with low specific volume, compared to a regular compressor which compresses a gas at a much higher specific volume. Since work or power for a flow process is an integral function of specific volume, then lower the specific volume, the lower the required power to compress it.

This research suffered from many experimental problems the most important of which was a venturi throat that was too long for its diameter. The venturi was cast and fabricated from lucite and plastic. The nozzle diameter was 0.75 inches and sloped down to a throat of 0.1 inch. The diffuser section expanded the throat back to 0.75 inches. The throat L/D was too high yielding a very large pressure drop (170 psig for a venturi inlet pressure of 200 psig) which defeated the purpose of compressing the gas. However, air was drawn into the throat at a pressure of 14.6 psi vacuum. This showed the promise of such a device with a better designed venturi.

Comparative Analysis of Helium Injection of a Gas Turbine

Researcher: Midshipman 1/C J.R. Messick, USN
Adviser: Assistant Professor Martin R. Cerza

The goal of this investigation was to determine whether Helium injection into a gas turbine held any beneficial effects for Naval applications of gas turbine technology. A stoichiometric analysis was performed to examine the theoretical results of adding helium into the combustion process of a small auxiliary power unit gas turbine. Data was also experimentally collected from test runs of five different helium flow rates at three distinct power settings. The data was collected with a Superflow data acquisition unit coupled to the 80 BHP Garret Gas Turbine located in the Marine Propulsion Laboratory of the United States Naval Academy. Also investigated was the relationship between air to fuel ratio and the adiabatic flame temperature. From the collection of theoretical and experimental data, it can be shown that the injection of helium into the gas turbine has an increased effect on fuel economy for a constant load setting. It is inconclusive, however, as to whether this fuel savings is due to the presence of helium in the combustion gases, thereby, modifying the combustion gases to exhibit a more ideal behavior, or if the fuel savings is solely due to an optimized air fuel ratio.

Construction Contract Modification Support Package

Researcher: Midshipman 1/C Erik Ostmo, USN
Adviser: Professor Bruce Johnson

One of the functions of the Navy's Civil Engineering Corps is to regulate and control the contracting and construction for all projects associated with the Navy. Even when the construction and contracting process is functioning perfectly, many problems can arise. For example, unforeseen conditions, errors and omissions of the architect/engineer during the designing stage, customer requested changes and other reasons can cause problems in the overall process.

When a problem does arise, the CEC officer who is acting as the project manager will tell the contractor to submit his price for the repair/change on the Contract Modification Form (NAVFAC 4330/43). The project manager will also fill out the same form. The two estimates are compared, altered if necessary, and negotiated until a mutually agreed price is obtained.

This process is complex and tedious to do by hand because some projects require many changes. Depending on the type of construction, there can be as many as 25 modifications or as little as 3. However, each time something is going to be modified, the CEC officer and the contractor must fill out the Contract Modification Form 4330/43.

This project automated the process so that both the estimates and the final modification forms containing the scope of work and corresponding costs are done on a Quattro Pro 5.0 spreadsheet. Numerous modifications can be done within minutes instead of hours and days. By using look-up tables and other tools offered by a 3-D spreadsheet, this project can speed up the modification process while providing more accurate figures than when done by hand.

Heated Micro-Climate Shelter For Diver Thermal Protection, Proof of Concept

Researcher: Midshipman 1/C John R. Schedel Jr., USN
Advisers: Professor Marshall L. Nuckols and
Lieutenant Commander William A. Davidson, USN

This project's aim was to test the ability of a thermal protection method using a heat source to create a warm "micro-climate" environment for divers in cold water. During a long, cold-water decompression, this method would offer a savings in both cost and space over more complicated surface supplied hot water suits or diver carried heating systems. Effects of surface heater capacity, water flow rate, shelter volume, and shelter insulation on micro-climate temperatures were characterized and confirmed by this experimentation. Both closed and open circuit options of the shelter were evaluated.

Both active and passive methods of thermally protecting divers on long, cold water dives have been sought for many years. Most active heating units restrict mobility, hamper diver performance and are generally not suited for remote missions with minimal surface support. The proposed system provides a simple, inexpensive means of heating the divers with little surface support

required. A hose from the outlet of an instantaneous hot water heater or other heat source runs down to a bag or suit used as a shelter. The hose provides water warmed by the heater; creating a thermal environment in which the diver can comfortably wait out the extended decompression schedule associated with deep water dives.

Surface support of such a method is relatively simple. The pump is submersed into the water and suctions the cold water into the heat source. After leaving the heat source, the pressure of the pump combined with gravity brings the warm water to the shelter. The shelter can consist of either an insulated "baggie" with elastic openings to allow the diver to swim inside or a "coveralls" suit that he can put on over his gear. If a closed circuit system is desired, another pump can pump the water via another hose back to the heater, completing the loop.

Publications

CERZA, Martin R., Associate Professor, Co-author, "An Experimental Investigation of Carbon Dioxide Bubble Clouds Rising and Dissolving in an Ocean Environment: The Effect of Flow Rate, Partial Pressure and Seawater Salinity," *Experimental Heat Transfer, Fluid Mechanics and Thermodynamics - 1993*, Elsevier, Amsterdam, The Netherlands, (1993), 1371-1377.

This investigation presents an experimental study of the carbon dioxide absorption process for gas bubbles comprised of both carbon dioxide and carbon dioxide and oxygen into both fresh water and seawater. The parameters investigated include the partial pressure of the carbon dioxide, the volumetric flow rate of the two gases, and the salinity of the seawater. The method of investigation was to determine the absorption of carbon dioxide into water of various salinities by measuring the change in the Ph of the ambient solution. A six foot plexiglass tower was used to create a water column through which the gas bubbles were percolated. The pH change of the water was measured at both the inlet and outlet of the tower. Three series of data were taken. The first two involved percolating first, pure carbon dioxide at various flow rates, then an O_2 and CO_2 mixture through fresh water. The last series of tests involved determining the absorption rate of carbon dioxide in waters of various salinities. These seawater tests showed that carbon dioxide was more readily absorbed in saltier waters.

CERZA, Martin R., Associate Professor, Co-author, "The Influence of Pool Circulation on Natural Convection and Pool Boiling of R113 from a Vertical Array of Tubes," *Transport Phenomena in Thermal Engineering*, Begell House, Inc., New York, New York, (1993), 496-504.

This paper reports the effect of pool circulation on the natural convection and pool boiling of R113 from a vertical array of horizontal tubes. Tests were conducted with increasing and decreasing heat flux. The pool circulation with respect to the heated tube array could be either in an upward or downward direction depending on whether the circulation was driven by natural convection from the heated tube array or by the circulation induced by the nucleating auxiliary heaters, respectively. The heat flux range of the heated tubes was 250 to 100,000 W/m^2. Pool circulation was determined to have a significant effect on the natural heat transfer coefficients from the heated tube array and no effect on the boiling heat transfer coefficients.

CERZA, Martin R., Associate Professor, Peter F. Wigins, Professor, and Lieutenant Commander Thomas E. O'Loughlin, USN. "An Experimental Investigation of the Effect of Helium Injection on Power Output and Overall Efficiency for a Rankine Cycle Plant," USNA Report EW-18-93.

The purpose of this investigation was to determine if the injection of helium into the feedwater system of a typical Rankine Cycle power plant would increase the total work output from the turbines and/or increase the cycle thermal efficiency. The Helium was injected into an "open" system. The helium would flow once through the cycle and not be reclaimed but the primary working fluid would be. The Rankine Cycle power plant utilized was the Steam Power Plant of the US Naval Academy's Marine Propulsion Laboratory. The plant was capable of delivering steam to the turbine throttle valve at 250 psig, 500°F into an operating condenser where pressures can be as low as 0.5 psia. The main steam flowrate was held constant at 2350 lbm/hr. The plant was retrofitted to inject a small amount of helium gas into the feedwater system on the discharge side of the feedwater pump, after the feedwater control valve, and before the steam drum in the oil fired boiler. The helium flow rate was varied in this study from 0.8 to 2.0 lbm/hr (77 to 194 SCFH) which corresponded to helium/steam mass ratios of 0.0348 to 0.0870%, respectively. Results indicated that with helium modified steam, the overall plant efficiency rose by 2% over the standard (unmodified) steam case.

DAVIDSON, William A., Lieutenant Commander, USN. "The Spirit of Annapolis - Preparing for the Human-Powered Submarine Race," *Human Power* 4(Fall 1993), 17-19.

This article chronicles the efforts of the US Naval Academy as they prepared for the third international human-powered submarine competition held in June 1993. The guiding design philosophy was to keep components "simple and reliable."

Initial effort was concentrated on determining how much power a human could produce underwater. Once this was accomplished a drive train and propeller were designed to maximize this output capability.

Emphasis was placed on modular construction to facilitate quick and easy repairs when needed. At the actual race this ability saved the Academy's submarine from being disqualified. Persistent problems with the drive train limited the speed to two knots which placed

the Academy in the middle of the pack.

The Academy will place greater emphasis on designing an efficient and reliable drive-train and propeller package as it is believed that this is where most of the improvements will take place in future competitions.

DAWSON, Thomas H., Professor, and David L. Kriebel, Associate Professor, "Experimental Study of Wave Groups in Ocean Swell," *Proceedings, International Conference on Offshore Mechanics and Arctic Engineering*, Glasgow, (1993), 1-8.

Results from a laboratory study of wave groups in scaled ocean swell are presented and compared with predictions from recent theory. Interest is in the narrow amplitude spectrum of ocean swell and the enhanced wave grouping associated with it. The average duration that the envelope of wave crests exceeds a specified threshold level and the average internal between such events are compared with predictions from envelope theory. Agreement is found to be good provided, as a result of extreme computational sensitivity, that the spectral coefficient in the theory is estimated from the measurements rather than calculated from spectral moments. Average durations and intervals associated with two or more high waves are shown to be related to the above envelope values through existing wave-group theory. The average number of wave crests exceeding a threshold level and the number between such runs are shown to be consistent with Markov theory under the same restriction on the spectral coefficient as found for envelope theory. Results from the laboratory study are extrapolated to full-scale conditions with the assistance of theory.

DAWSON, Thomas H., Professor, and David L. Kriebel, Associate Professor, "Nonlinearity in Crest-Trough Statistics of Bretschneider Seas," *Proceedings, International Conference on Offshore Mechanics and Arctic Engineering*, Houston, (1994), 27-36

Nonlinearity in the statistics of Bretschneider seas is examined both theoretically and experimentally using the concept of crest and trough envelope functions. For fixed threshold levels above and below mean water level, consideration is given to the average number of crests associated with the duration that the crest envelope exceeds this upper level and the average number of troughs associated with the duration that the trough envelope exceeds this lower level. Similar considerations are given to the average number of crests and troughs associated with the interval between the beginnings of

such events. Predictions are shown to be in good agreement with laboratory measurements. Theory is also considered for related wave group phenomena, and predictions are likewise shown to be in good agreement with measurements. Nonlinear effects in crest and trough statistics of Bretschneider seas are concluded to be well represented by the relations considered here.

DAWSON, T. H., Professor, David L. Kriebel, Associate Professor, and L. A. Wallendorf, Ocean Engineer, "Breaking Waves in Laboratory-Generated Jonswap Sea," *Applied Ocean Research*, 15, (1993), 85-93.

Results from a laboratory study of wave breaking in deep-water random seas are presented for approximate Joint North Sea Wave Project (JONSWAP) sea states. Waves generated at one end of a 116-meter wave tank are observed for breaking at a section of the tank approximately 30 meters from the wavemaker and in regions spanning three and six meters about the section. Emphasis is on the relative number of breaking waves observed at the section and in the regions about it, and on the relative number of crest amplitudes exceeding specified levels at the section. Measurements at the section are shown to be in good agreement with predictions formed using idealized assumptions about the breaking waves and a modified Rayleigh distribution of crest amplitudes that accounts approximately for nonlinear effects in seas with narrow-banded wave frequencies. Results indicate that the average downward crest acceleration of breaking waves in these sea states is equal approximately to one-third the acceleration of gravity. Experimental measurements of breaking in regions about the section are shown to be in good agreement with theoretical predictions relating breaking events over a region to those at a fixed location.

HAWLEY, J. Gary, Lieutenant Commander, RN, Co-author, "A Non-Air-Breathing Diesel Engine Research Facility," 28th Intersociety Energy Conversion Engineering Conference, Atlanta, GA, (August, 1993), 967-975.

Non-air-breathing diesel engine systems have, and continue to be developed for underwater applications. The overall designs of these individual systems has been influenced by the technique employed to remove and dispose of the surplus exhaust gas from the operating cycle. The systems currently undergoing development have concentrated on ensuring that the thermodynamic properties of the re-circulated gases approach those of free air. Subsequently, the diesel engine can then theoretically operate at or near its design condition.

However, this has led to the design of complicated and space consuming exhaust gas removal and absorption systems. The ability of the engine to operate within acceptable performance limits on purely carbon dioxide and oxygen mixtures would result in a simpler and more attractive system. This paper details the design, construction and initial experimental results from a diesel engine that has been configured to operate on oxygen and carbon dioxide atmospheres.

HAWLEY, J. Gary, Lieutenant Commander, RN, Co-author, "Investigation of Non-Air Diesel Engine Systems," 28th Intersociety Energy Conversion Engineering Conference, Atlanta, Georigia, (August 1993), 875-880.

An investigation into the use of non-air intake mixtures in diesel engine power systems has shown that under carefully controlled conditions the performance of such engines is comparable to that with normal air oxidants. Moreover, it has been found that the operation of diesel engines is remarkably tolerant to high intake concentrations of carbon dioxide. If the intake charge is pre-heated and oxygen enrichment is used then carbon dioxide concentrations as high as 70% can be used. As well as the experimental trials on both direct and indirect injection engines, a parallel analytical investigation has given some insight in the in-cylinder processes involved in the non-air operation of such engines. This paper describes the experimental and analytical techniques that have been developed to assess the performance of non-air diesel systems.

HAWLEY, J. Gary, Lieutenant Commander, RN, "The Results of an Experimental Investigation on a Non-Air-Breathing Diesel Engine System," 8th International Symposium on Unmanned Untethered Submersible Technology, North Eastern University, Massachusetts, (September 1993) 420-426.

Non-air-breathing diesel engine systems have, and continue to be developed for underwater applications. When operated in this manner the engine ingests a mixture of oxygen and recycled exhaust gas. The main problem surrounding the operation of the diesel engine in this mode has been the associated recycle of a sizeable proportion of the carbon dioxide produced during combustion and its detrimental effect upon the engine's performance. Efforts to avoid this problem have resulted in the evolution of increasingly complex systems. However, the ability of the engine to operate within acceptable performance limits on purely carbon dioxide and oxygen mixtures would result in a simpler and more attractive system. This paper presents the main experimental results that have been obtained from a diesel engine that has been configured to operate on oxygen and carbon dioxide atmospheres.

HAWLEY, J. Gary, Lieutenant Commander, RN, Co-author, "Diesel Engine Research for Underwater Applications," Transactions of the Institute of Marine Engineers, UK, (1993), 61-75.

The Defense, commercial and scientific communities are all aware of the strategic importance of the world's oceans. Future underwater operations are under consideration based on both manned and unmanned vessels. Consequently, studies of suitable power systems which are able to provide high reliability coupled with long underwater duration has intensified over the last decade. One system which has attracted attention as a short-term, cost-effective solution is the non-air-breathing diesel engine. When used underwater, this engine ingests a mixture of oxygen and recycled exhaust gas. The main problem surrounding the operation of the diesel engine in this manner has been the associated recycle of a sizeable proportion of the carbon dioxide produced during combustion, with detrimental effects on the engine's performance. Efforts to avoid this problem have resulted in the evolution of systems of increasing complexity which have proved successful for large manned submersibles where limitations on space and weight are not critical. However, for the small manned and unmanned application, the ability of the engine to operate in recycle mode within acceptable performance limits on an oxygen and carbon dioxide mixture, offers numerous advantages.

This paper presents the major findings of an experimental investigation carried out on a carbon dioxide/oxygen breathing diesel engine operating on artificially created recycle atmospheres.

HAWLEY, J. Gary, Lieutenant Commander, RN, Co-author, "Autonomous Underwater Vehicles," Proceedings, Part A, Journal of Power and Energy, Institution of Mechanical Engineers, UK, 208 (1994), 37-45.

Future underwater operations are under evaluation using autonomous ocean-ranging submersibles of the unmanned variety. Such vessels are commonly termed Autonomous Underwater Vehicles (AUVs), and the search for suitable power systems which are able to provide high reliability coupled with long underwater durations has intensified over the last decade. This paper presents a review of those power systems that are under

consideration, design and development mainly for the AUV application.

JOHNSON, Bruce, Professor, "Final Report and Recommendations to the 20th ITTC from the Symbols and Terminology Group," Proceedings, 20th International Towing Tank Conference, San Francisco, California, Volume 1 published by U.C. Berkeley (September 1993), 67-78.

The work accomplished in the 1990/93 period resulted in the 1993 Version of the ITTC Symbols and Terminology List. The introduction to the 1993 Version describes in detail the philosophy and the practice which directed the Group activities concerned with Symbols and Terminology.

JOHNSON, Bruce, Professor, "Committee Discussions and Replies from the Symbols and Terminology Group," Proceedings, 20th International Towing Tank Conference, San Francisco, California, Volume 2, published by U. C. Berkeley, (September 1993), 27-32.

The Symbols and Terminology Group, formed in October 1985, has produced three versions of the Standard Symbols and Terminology List. The first one was distributed to all ITTC members during the Kobe Conference (October 1987); the second version was distributed during the Madrid Conference (September 1990), while the third one has been prepared for distribution before the 20th Conference.

KRIEBEL, David L., Associate Professor, and Robert H. MAYER, Associate Professor, "Wave Runup Prediction on Curvilinear Slopes," Proceedings, Seventh Annual National Conference on Beach Preservation Technology, Tampa, Florida, (February 1994), 442-458.

Predictions of wave runup are useful in estimating the elevation and landward extent of the erosion scarp of an eroding beach and are necessary to properly design the profile of a beach fill. One problematic feature of existing wave runup formulas, however, is their functional dependence on a single uniform beach slope. For open-coast beaches, which are generally concave in shape, such a uniform slope is difficult to define. In this paper, an integrated method for calculating wave runup on composite and curvilinear slopes is described. Results of laboratory testing on bi-planar and equilibrium beach profiles are presented and are shown to compare favorably with the predicted wave runup.

KRIEBEL, David L. and Thomas H. Dawson,

"Nonlinearity in the Wave Crest Statistics," Proceedings, Ocean Wave Measurements and Analysis, New Orleans, Louisiana, (1993), 61-75.

The statistical properties of nonlinear wave crest's amplitudes are discussed for a narrow-band random sea consistent with Stokes second-order wave theory. In particular, the probability distribution for nonlinear crest amplitudes is shown to be a modified form of the Rayleigh distribution that incorporates nonlinear effects through a spectral wave steepness parameter. Predictions from this distribution are shown to be in close agreement with laboratory data and with recently published North Sea measurements for both deep water and intermediate depth conditions. This distribution is then modified to account for wave breaking in a random sea and results are again shown to be in good agreement with laboratory data.

KRIEBEL, David L., Associate Professor, "Nonlinear Runup of Random Waves on a Large Vertical Cylinder," Proceedings, 12th Offshore Mechanics and Arctic Engineering Conference, Glasgow, Scotland, (1993), 49-56.

An experimental investigation was conducted to document extreme loading on a vertical production caisson (30-inch diameter steel pile containing a producing oil well) in waves and currents with depth-limited breaking waves. This work was motivated by recent failures of these structures during Hurricane Andrew in the Gulf of Mexico. In addition, there are continued uncertainties in the way wave-current interactions are treated in wave force calculations as recommended by the American Petroleum Institute. Several sets of laboratory experiments are conducted in a large wave tank in order to provide design guidance. Tests are conducted at a 1-to-20 scale with a single vertical cylinder instrumented to measure in-line and transverse forces and overturning moments. Tests simulate "shallow water" Gulf of Mexico conditions with a full-scale water depth of 50 feet and with wave heights of up to 40 feet.

KRIEBEL, David L., Associate Professor, Co-author, "WaveTransformation Measurements at SUPERTANK," Proceedings, Coastal Dynamics '94 Conference, Barcelona, Spain, (February 1994), 61-75.

The SUPERTANK Data Collection Project, sponsored by the Army Corps of Engineers, was conducted during August and September 1991 at the Wave Research Laboratory of Oregon State University. The goal of the

project was to collect data on nearshore waves and sediment transport under controlled conditions at prototype scale in a large wave tank. Over 30 investigators from the United States and several other countries took part in this project. The goal of this research was to measure wave conditions in the so-called swash zone between the still water shoreline to the upper limit of wave runup. Preliminary data analysis has been completed and a report has been published by the Army Corps of Engineers.

LINDLER, Keith W., Associate Professor, "Improving the Performance of Thermoelectric Heat Pumps by Use of Multi-Stage Cascades," Proceedings, 28th Intersociety Energy Conversion Engineering Conference, Atlanta, Georgia, (August 1993), 1879-1883.

A thermoelectric heat pump is a miniature solid state device used to pump small amounts of heat. Potential uses range from the cooling of electronic components to dorm size refrigerators. An ongoing study at the United States Naval Academy proposes to use a miniature thermoelectric heat pump to maintain a neutron dosimeter at near constant temperatures in order to obtain more accurate readings. Unfortunately, the coefficient of performance of the heat pump decreases rapidly with increasing temperature difference. The current study investigates the potential improvement in heat pump performance that can be obtained by cascading two or more heat pumps in series operation.

MAYER, Robert H., Associate Professor, "Shore Protection Plans for Coastal Beaches: A Contemporary O/E Design Experience," USNA Report EW-09-93, (June 1993).

Given the economic importance of coastal regions, two capstone design projects have been developed to enhance the design experience of ocean engineering majors at the U.S. Naval Academy. The students are required to develop shore protection plans for two Mid-Atlantic coastal sites. The projects encompass most aspects of the design process including requirements assessment, data collection and analysis, alternative generation, interrelated engineering and economic evaluations, and design decision-making with uncertainty. This paper discusses the two design projects and details student efforts during each step of the design process.

MOURING, Sarah E., Assistant Professor, "Guidelines to Minimize Floor Vibrations from Building Occupants,"

Journal of Structural Engineering, ASCE, Vol. 120, No. 2 (February 1994), 507-526.

One major serviceability consideration in modern buildings is excessive floor vibrations due to occupant activities. Floor vibrations are becoming a more important design consideration with the use of high-strength, light-weight materials in building structures, longer floor spans, and more flexible framing systems. Floor systems in shopping malls, pedestrian walkways and concourses, and gymnasiums are relatively light and susceptible to vibration problems. Methods for accurate prediction of these vibrations and evaluation of floor systems are not readily available to the design community. An investigation is made into the characteristics of crowd-induced loads. These characteristics included the density of the crowd, randomness of crowd movement, crowd activity, and temporal interaction between individuals. Analytical procedures are developed to determine the influence of each load characteristic on the dynamic response of floor systems. Design guidelines are developed for floors in malls, gymnasiums, and walkways subject to crowd-induced loads.

NELSON, Martin E., Professor, Co-author, "Comparison of Neutron Measurements at LINACS using Bubble Dosimeter to other Neutron Detectors," *Radiation Protection Dosimeters*, Volume 47, (1993), 547-550.

The responses are presented of bubble dosimeters and several other dosimetry devices when used to measure neutron production at two different electron linear accelerators (linacs), one of which is used in chemotherapy. The accelerators produced maximum beam energies of 20 and 40 MeV respectively. The first linac studied was located in a hospital and used in chemotherapy treatments The second was used for industrial irradiations. The devices compared with the bubble dosimeter included etched track devices (CR-39), and thermoluminescent detectors (TLD). Since the detectors were placed at different axial and radial locations, results are given on the neutron spatial distribution around each accelerator. Data is also presented for different linac collimator configurations. The study found relatively large differences in the measured neutron dose between the TLD and other devices. An explanation of these and other results is given in the paper.

NUCKOLS, Marshall L., Professor, "Heated Diver Decompression Shelter: The Womb Concept," *Journal of Ocean Engineering*, 21, 5, (July 1994), 433-443.

A hybrid thermal protection method using waste heat from a surface-mounted outboard motor is shown to create a warm "micro-climate" environment for divers. The effects of surface heater capacities, water flow rates, shelter volume and shelter insulation on micro-climate temperatures are characterized. During long, cold-water decompression stops, this method offers a reliable, low-cost alternative to surface-supported hot water suits or diver-carried heating systems. An added bonus for divers using a closed-circuit breathing apparatus is prolonged duration of their carbon dioxide scrubbers when surrounded by the warm water "micro-climate." Closed-circuit and open-circuit options of this diver decompression shelter concept are evaluated.

NUCKOLS, Marshall L., Professor, "Effective Thermal Conductivity of a KEVLAR-Reinforced Electro-Mechanical Cable for ROV Applications," Proceedings, Underwater Intervention '94, San Diego, California, (February 1994), 167-174.

The effective thermal conductivity of a composite, consisting of the inner sheath, outer sheath and strength member of an electro-mechanical cable, was experimentally measured. Data from this investigation is used with steady-state and transient models to predict temperature distributions for cable reels in various operational scenarios and environmental conditions. The experimental procedure is described for thermal measurements and data is presented for a KEVLAR-reinforced electro-mechanical cable.

NUCKOLS, Marshall L., Professor, Co-author, "Passive Methods of Thermal Protection for Cold Water Diving," Proceedings, Underwater Intervention '94, SanDiego, California, (February 1994), 245-252.

Four methods of protecting divers against the life-threatening effects of cold water exposures are discussed. All four methods rely on passive protection, resulting in prolonging diver mission durations without the need to supply active heating sources. Predictions of acceptable mission durations are proposed using these passive protection techniques. An insulating technique is proposed using liquids which eliminate the problem of excessive suit buoyancy normally associated with passive protection systems. The results of thermal testing are presented which indicate that this liquid-insulated garment can maintain a diver within established thermal performance criteria for up to 5 hours in 32°F water.

NUCKOLS, Marshall L., Professor, "Thermal Protection Options for EOD Divers," USNA Report EW-10-93, (August 1993).

A hybrid thermal protection method using waste heat from a surface-mounted outboard motor is proposed to create a warm "micro-climate" environment for divers. Closed-circuit and open-circuit options of this diver decompression shelter concept are evaluated. The power requirements, thermal efficiencies and characteristics of various active heating systems have been evaluated for comparison with an existing thermo-electric heat pump system (DATPS) presently under development for the Special Warfare community. The mission requirements established for this analysis called for a small, light-weight heating system that can be deployed from a small craft such as an inflatable boat or a small Whaler. The system requirement called for adequate heating for two divers in 32°F water for up to 6 hours during a decompression phase of a mission. The system may have the power source on the surface boat or on the underwater diver decompression stage.

TUTTLE, Kenneth L., Associate Professor, "Electronic Data Acquisition," Proceedings, ASEE Annual Conference, Champaign-Urbana, Illinois, (June 1993), 2005-2008.

Computerized ocean engineering data acquisition systems and elctronic data acquisition equipment at the U.S. Naval Academy Marine Propulsion Laboratories is described. There are many advantages to electronic data acquisition, especially when the data logger has programmable computational abilities. Traditionally, an experimentation researcher could take more data in a week than could be reduced and analyzed in a year. In addition to speed and accuracy, computerized electronic data acquisition accelerates data reduction and analysis enough to substantially speed the research process both in terms of getting and reporting results as well as in terms of getting feedback for follow-up experiments.

WHITE, Gregory J., Professor, Co-author, "A Methodology for Reliability Assessment of Ship Structures," Ship Structures Symposium 1993, Arlington, Virginia, (November 1993), H1-H10.

This paper presents a methodology to assess the reliability of an important and representative failure mode of a ship: buckling of deck panels. This methodology uses tools for the evaluation of the limit-states, modeling

of the loads, geometry and material properties, reliability assessment and sensitivity analysis. The proposed methodology estimates the failure probabilities of the above failure modes, identifies the most important uncertainties and determines the most effective design modifications that result in the highest improvements in reliability. The methodology is illustrated by analyzing the reliability of a cruiser.

Presentations

BAKER Bradford, Midshipman 1/C, USN and Martin E. Nelson, Professor, "Investigation of Alternate Droplet Material Bubble Dosimeters," 1994 Health Physics Society, San Francisco, California, June, 1994.

CASSATA, James R., Lieutenant, USNR, "Total Quality Teaching," New Instructor Orientation, U.S. Naval Academy, August 1993.

CASSATA, James R., Lieutenant, USN, "A Methodology for Measuring the Effects of Gamma and Electron Irradiation on Level II Electronic Packaging Material," Faculty Forum, University of Maryland, College Park, Maryland, December 1993.

CASSATA, James R., Lieutenant, USNR, "The Advanced Pressurized Water Reactor - 600," ENNU 465 in class presentation, University of Maryland, College Park, Maryland, April 1994.

CERZA, Martin R., Assistant Professor, "An Experimental Investigation of Carbon Dioxide bubble Clouds Rising and Dissolving in an Ocean Environment: The Effect of Flow Rate, Partial Pressure and Seawater Salinity," The Third World Conference on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics, Gas-Liquid Flow Symposium, Honolulu, Hawaii, November 1993.

DAWSON, Thomas H., Professor, "Nonlinearity in Crest-Trough Statistics," presented at the ONR Workshop on Nonlinear Waves, Tucson, Arizona, 17 March, 1994.

HAWLEY, J. Gary, Lieutenant Commander, RN, "The Results of an Experimental Investigation on a Non-Air-Breathing Diesel Engine System," 8th International Symposium on Unmanned Untethered Submersible Technology," North Eastern University, Massachusetts, September 1993.

HAWLEY, J. Gary, Lieutenant Commander, RN, "Non-Air-Breathing Diesel Submarine Engines," Eleventh Naval History Symposium, United States Naval Academy, 21 October 1993.

JOHNSON, Bruce, Professor, "Final Report and Recommendations to the 20th ITTC from the Symbols and Terminology Group," The 20th International Towing Tank Conference, San Francisco, California, 19-25 September 1993.

KRIEBEL, David L., Associate Professor, "Wave Transformation Measurements at SUPERTANK," Coastal Dynamics '94 Conference, Barcelona, Spain, 24 February 1994.

KRIEBEL, David L., Associate Professor, and Robert H. MAYER, Associate Professor, "Wave Runup on Curvilinear Slopes," Beach Preservation Technology Conference, Tampa, Florida, 11 February 1994.

KRIEBEL, David L., Associate Professor, "Nonlinearity in Wave Crest Statistics," 2nd Intl. Symp. on Ocean Wave Measurement and Analysis, New Orleans, Louisiana, 27 July 1993.

KRIEBEL, David L., Associate Professor, and Thomas H. DAWSON, Professor, "Nonlinearity in Wave Statistics and Wave Groups", Shell Development Company, Houston, Texas, 31 August 1993.

KRIEBEL, David L., Associate Professor, "Nonlinear Runup of Random Waves on a Large Vertical Cylinder," 12th Intl. Offshore Mechanics and Arctic Engineering Conference, Glasgow, Scotland, 22 June 1993.

KRIEBEL, David L., Associate Professor, "Wave Transformation Measurements at SUPERTANK", University of Delaware, Department of Civil Engineering, 7 April 1994.

KRIEBEL, David L., Associate Professor, and Robert H. Mayer, Associate Professor, "Wave Runup on Composite-Slope and Concave Beaches," Seminar at the Army Corps of Engineers' Waterways & Experiment Station, Vicksburg, VA, September 1993.

LINDLER, Keith W., Associate Professor, "Improving the Performance of Thermoelectric Heat Pumps by Use of Multi-Stage Cascades," 28th Intersociety Energy Conversion Engineering Conference, Atlanta, Georgia, 8-13 August 1993.

MAYER, Robert H. Associate Professor, "Shore Protection Plants for Coastal Beaches: A Contemporary O/E Design Experience," at the 1993 Centennial Conference of ASEE, Urbana-Champaign, Illinois, June 1993.

NELSON, Martin E., Professor, "Use of Nuclear Data Acquisition Systems at the U.S. Naval Academy", 1993 ASEE Annual Conference Proceedings, Chicago, Illinois, 20 June 1993.

NELSON, Martin E., Professor, "Soil Remediation Using Air Classification Technology", American Nuclear Society Annual Meeting, New Orleans, Louisiana, June 1994.

NELSON, Martin E., Professor, "Separation of Heavy Metals from Soils Using Air Classification Technology," American Nuclear Society, San Diego, California, 6 June 1993.

NUCKOLS, Marshall L., Professor, "Heated Diver Decompression Shelter: The Womb Concept,"

Underwater Intervention '94, San Diego, California, 7-10 February 1994.

NUCKOLS, Marshall L., Professor, "Passive Methods of Thermal Protection for Cold Water Diving," Underwater Intervention '94, San Diego, California, 7-10 February 1994.

NUCKOLS, Marshall L., Professor, "Effective Thermal conductivity of a KEVLAR-Reinforced Electro-Mechanical Cable for ROV Applications, " Underwater Intervention '94, San Diego, California, 7-10 February 1994.

NUCKOLS, Marshall L., Professor, "Diver Thermal Protection," Undersea and Hyperbaric Medical Society Workshop on Diver Related Problems, San Diego, California, 10 February 1994.

TUTTLE, Kenneth L., Associate Professor, "Electronic Data Acquisition," American society for Engineering Education, Annual Conference, Champaign-Urbana, Illinois, June 1993.

WHITE, Gregory J., Professor, "A Methodology for Reliability Assessment of Ship Structures," Ship Structures Symposium '93, Arlington, Virginia, 16-17 November 1993.

Weapons and Systems Engineering

Professor Robert DeMoyer
Chair

Research within the Weapons and Systems Engineering Department continues to provide the faculty with an opportunity to grow professionally and to keep abreast of rapidly advancing systems technology. In addition, every graduating Systems Engineering major participates in independent research, design, and development projects for the purpose of realizing practical application of some of the theory which they have studied.

Every faculty member, both civilian and military, either participates in independent research in areas of interest to the U.S. Navy, or supports midshipmen research programs in an advisory capacity. Faculty research areas include neural networks, turbine modeling and control, composite materials, pattern recognition for medical diagnostics, and fuzzy logic applications in control.

This year there were three Trident Scholars in the Systems Engineering Department. They engaged in extensive research projects in lieu of several courses, and produced publishable results. Their research topics include magneto-hydrodynamic free convection flow, brainwave control of a telerobotic manipulator, and fuzzy logic applications in weapons platform control.

Strong emphasis continues on the faculty - midshipman relationship during the student independent research course. Each midshipman is assigned both an administrative and a technical advisor. These advisors not only provide support of a technical nature, but also emphasize planning, scheduling, and effective oral and written presentation. Typical examples of midshipmen research projects include a walking robot, remote controlled vehicles, line following vehicles, vibration analysis, magnetic levitation, inverted pendulum, light tracker, and wall climber.

Funding for research continues to be diverse. This year sponsors included the Naval Academy Research Council, the Office of Naval Research, and Naval Surface Warfare Centers at Carderock and at Dahlgren.

Sponsored Research

Neural Network Applications to Structure-borne Noise Reduction

Researcher: Assistant Professor William I. Clement
Sponsor: Naval Academy Research Council (ONR)

The Annapolis Division of the Naval Surface Warfare Center, Carderock (Code 1927) conducts submarine acoustic trials for the purpose of locating and reducing sources of radiated noise aboard ship. The quantities of data they collect make it impossible for technicians to process it in real-time. This research focused on developing an automated means by which to analyze the vibration characteristics of its submarine fleet. Previous research in this area showed artificial neural networks to be an effective solution. However, tests on a wider body of data are necessary as are custom software tools to make a fleet-ready analysis package. This research concentrated on these two aspects of the problem. The result is a single software package which allows data collected with current U.S. Navy equipment to be grouped, analyzed, and classified by an artificial neural network.

A Steam-Augmented Gas Turbine and Reheat Combuster Model for Surface Ships

Researchers: Professors Terrence E. Dwan, E. Eugene Mitchell and
Associate Professor Jerry W. Watts
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The steam-augmented gas turbine (SAGT) concept as applied to propulsive and auxiliary power on Navy surface ships, has several very positive aspects. It improves fuel efficiency, it allows for sudden bursts of power (much like turbocharging), and it reduces NO_x emissions. The single negative, that it puts steam back into the picture, is not really a negative since the required steam plant for the SAGT engine would be considerably different from the steam plant required for previous steam turbine engines. This research will use modeling equations already developed by Urbach, et. al. to produce a FORTRAN program using a 11 state Newton-Raphson convergence technique. Two compressor maps and three turbine maps will be added so that off-design equilibrium points can be obtained with the model. Further work will then produce a dynamic model so that transient performance can be observed.

Fluid Dynamic Behavior of a Hot Vertical Plate in Unsteady Viscous Flow of an Incompressible Fluid with Variable Suction and in a Magnetic Field

Researcher: Midshipman 1/C David W. Fink, USN
Advisers: Professor Robert Granger and Assistant Professor William I. Clement
Sponsor: Trident Scholar Program

This study involved the analysis of a magneto-hydrodynamic free convection flow past the unsteady motion of a hot vertical plate. Free convection was studied with an incompressible, electrically conducting viscous fluid over a vertical plate moving exponentially in its own plane. This study included the effects of magnetic variations on the velocity profile. The effects of temperature and variable suction were not obtained. Exponential motion was chosen because cardiovascular flow in humans follows with such a profile. This analysis may be relevant to the treatment of cardiovascular disease. The theoretical investigation began with a Newtonian fluid, even though blood is non-Newtonian. A future effort will be to extend the results of the Newtonian portion of the investigation to apply to non-Newtonian fluid.

Telerobotic Control Using Muscular and Neural Electrical Signals

Researcher: Midshipman 1/C William M. Gotten, USN
Adviser: Professor Kenneth A. Knowles
Sponsor: Trident Scholar Program

It has been known for some time that human organs are capable of producing repeatable and measurable electrical potentials. Current standardized medical diagnostic tests are used to measure heart voltages (the electrocardiogram, or EKG), muscle group voltages (the electromyogram, or EMG), and brain wave voltages (the electroencephalogram, or EEG). This project investigates the feasibility and practical implementation of a system which uses signals similar to those obtained by the EEG and EKG as command inputs for the real-time control of a telerobotic manipulator arm. In the process of conducting this research, monitoring devices were designed and constructed, suitable signal groups identified, appropriate control strategies and algorithms developed, and finally, a complete telerobotic control system was integrated in such a manner as to provide a robust and user-friendly environment. The ultimate objective of this research is to develop a "hands-off" control methodology to augment or replace existing manual control systems. The possible applications of this project range from prosthetic devices to aircraft flight and subsystem control augmentation.

An Application of Fuzzy Logic Control to a Classical Military Tracking Problem

Researcher: Midshipman 1/C Erik S. Smith, USN
Adviser: Assistant Professor Carl E. Wick
Sponsor: Trident Scholar Program

This project explores the use of fuzzy logic as a means of controlling an altitude-azimuth tracking system that can be found in many military weapon systems. The sensor used in this effort was a telescope mounted quadrant sensor, while the target was the reflected energy from a helium-neon laser. The investigator constructed a two-dimensional fuzzy logic computing system from RISC processors and demonstrated the feasibility of using fuzzy logic to provide weapons platform control.

A Simplified Purkinje Image Eye Tracker

Researcher: Assistant Professor Carl E. Wick
Sponsor: Naval Academy Research Council (ONR)

This effort continues the research and development of a system that tracks images of infrared light reflected from two optical surfaces of the eye. Previous experiments have shown that a collimated infrared light emitting diode and charge coupled device camera were sufficient to produce and receive detectable reflection signals from the eye cornea and interior lens. In this year's work, the signals were successfully separated from the background in near-real time through the use of a special fuzzy logic circuit. Work will continue to improve the system performance in a variety of working conditions.

Independent Research

Feedback System Controller Design by Inverse Frequency Response

Researcher: Associate Professor Thomas E. Bechert

A feedback control system's desirable properties of rapid response without appreciable overshoot may be specified in the frequency domain by high gain-crossover-frequency and high phase margin. A novel method has been investigated for converting these performance specifications into circuit design parameters. The method is essentially graphical. The controlled plant's Nyquist diagram is plotted; the controller's inverse frequency response function is plotted on the same axes. Points of intersection represent solutions to the design problem. The method provides greater intuitive understanding of design feasibility when compared to standard Bode design techniques.

Using GALs in an Introductory Digital Design Course

Researcher: Assistant Professor Carl E. Wick

This study is a synthesis of ARMA Filters by Real Lossless Digital Lattices. The task of introducing undergraduate engineering students to the fundamentals of digital systems is becoming more challenging each year. Many of these challenges come in the development and execution of laboratory exercises, where the mechanical complexities of breadboarding many integrated circuits often results in failure with students (and sometimes instructors) lost in a forest of wires with a circuit that does not work. A component was found that simplifies the development and execution of digital laboratory exercises, and additionally provides students some experience in several modern technologies. This paper describes how the component, the Generic Logic

Device (GAL), was successfully used in an introductory digital logic class presented to Systems Engineering majors.

Research Course Projects

Acoustic Boiling Detection

Researcher: Ensign G. Daniel Doney, USN
Adviser: Assistant Professor William I. Clement

Experiments were performed to gather data on the effects of changing bulk temperature and power levels in water on the sound of boiling. This information was formatted and used to train an artificial neural network to recognize the onset of boiling. The trained network is a predictor of boiling under the experimental conditions. With more development, the detector could possibly be used to provide important coolant information for pressurized or boiling water nuclear reactors, thereby expanding the envelope of safe operations.

Design Course Projects

Each Systems Engineering major enrolls in ES402, Systems Engineering Design, during senior year. This course is the capstone of the Systems Engineering curriculum. The student is required to propose, design, construct, test, demonstrate, and evaluate a system of particular personal or general professional interest.

The ES402 design course requires the combined effort of the total Systems Engineering Department faculty. Military instructors normally function as project monitors and help with organization, administration, and scheduling of individual projects. Civilian faculty function as technical advisors, and military and civilian technicians supply the hands-on technical help.

Professor Kenneth A. Knowles and Associate Professor Olaf N. Rask provided the course coordination and administrative effort. They were assisted by Professors Robert DeMoyer, Terrence E. Dwan, and E. Eugene Mitchell, Associate Professors Thomas E. Bechert, and Jerry W. Watts, and Assistant Professors William I. Clement, George E. Piper, and Carl E. Wick, who provided technical and systems design assistance and expertise for the listed design projects.

The results of academic year 1993-1994:

Step-Climbing Wheelchair
Midshipmen 1/C Gregory B. Ames and
Mark D. Johnson, USN
Adviser: Lieutenant Patrick D. Gardner, USN

Active Magnetic Suspension
Midshipman 1/C Peter L. Antonacci, USN
Adviser: Commander Michael F. Dulke, USN

Targeting/Neutralization System for Small Arms
Midshipmen 1/C Cristian E. Avendano and
Matthew P. Bartel, USN
Adviser: Lieutenant Commander Charles O. Stephenson, USN

WEAPONS AND SYSTEMS ENGINEERING

Voice-Controlled Lock
Midshipmen 1/C Lee G. Baird and
James E. Hail, USN
Adviser: Lieutenant Stepehen A. Modzelewski, USN

Robotics Self-Propelled Artillery
Midshipmen 1/C Craig R. Beal
and David C. Wallis, USN
Midshipman 2/C Jesko M. Hagee, USN
Adviser: Captain Charles B. McClelland, USMC

Virtual Reality: Simulation Applications
Midshipman 1/C Jeffrey J. Carty, USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

Braille Printer
Midshipman 1/C Kirk L. Clermont and
Nicholas L. Edwards, USN
Adviser: Lieutenant Dennis A. Maloney, USN

Automatic Targeting Composite Crossbow
Midshipmen 1/C Heath T. Dewitz and
Robert E. Wirth, USN
Adviser: Lieutenant Patrick D. Gardner, USN

Two-Legged Walking Robot
Midshipmen 1/C Sean M. Fahey, James E. O'Harrah and Michael G. Rosenbaum, USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

Voice-Controlled Wheelchair
Midshipman 2/C Zachary K. Gillen, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Electronic Door Security System
Midshipmen 1/C Eric W. Green and
Clinton D. Moxey, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Video Telephone System
Midshipman 1/C Matthew W. Hartkop, USN
Adviser: Lieutenant Commander Paul E. Thurman, USN

Autonomous Sailboat
Midshipmen 1/C David E. Bolduc and
Jeffrey L. Hockett, USN
Adviser: Commander William H. Campbell, USN

Autobalancing Landsailor
Midshipman 1/C Gregory H. Hryniewicz, USN
Adviser: Lieutenant Commander Paul E. Thurman, USN

WEAPONS AND SYSTEMS ENGINEERING

Automatic Fishing Pole
Midshipman 1/C Matthew C. Jackson, USN
Adviser: Commander John A. Hancock, USN

Active Underwater Sound Cancellation
Midshipman 1/C Richard M. Johns, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Tracking Deceptive Radar Jammer
Midshipman 1/C Adam S. Kinnear, USN
Adviser: Lieutenant Commander Richard J. McGraw, USN

Differential GPS Autolocator
Midshipman 1/C Jon R. Lunglhoffer, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Optical Track-Following Cart
Midshipmen 1/C Kevin S. Mattix and
Darryl L. Wilson, USN
Adviser: Commander Michael F. Dulke, USN

Resin Optimization of Kelvar Bullet Stopping
Midshipman 1/C Anthony H. Miller, USN
Adviser: Lieutenant Peter S. Allison, USN

Digital Car Alarm System
Midshipman 1/C Steven L. Miller, USN
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

Automatic Downed Pilot Retrieval System
Midshipmen 1/C Joseph M. Nowicki and
Joseph M. Silver, USN
Adviser: Lieutenant Dennis A. Maloney, USN

Voice-Controlled Remote Control
Midshipman 1/C Steven P. Olivera, USN
Adviser: Lieutenant Peter S. Allison, USN

Auto-Umpire
Midshipmen 1/C Erik L. Ostmo and
William B. Scally, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Microprocessor Control USNA Hybrid Vehicle
Midshipman 1/C Patrick L. Padgett, USN
Adviser: Lieutenant Patrick D. Gardner, USN

Workstation for the Handicapped
Midshipman 1/C Brody L. Prieto, USN
Adviser: Lieutenant Dennis A. Maloney, USN

Keyboardless Data Entry
Midshipman 1/C Kevin G. Quinn, USN
Adviser: Captain Charles B. McClelland, USMC

Four Wheel Steer/Drive
Midshipmen 1/C Anthony E. Rossi and
Edward M. Stout, USN
Adviser: Lieutenant Patrick D. Gardner, USN

Automatic Fingerprint/ID Identifier
Midshipmen 1/C Brent D. Sadler and
Michael J. Supko, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Network Control of Robotics Laboratory
Midshipman 1/C John B. Salmon, USN
Adviser: Lieutenant Peter S. Allison, USN

Remote Automobile Starter
Midshipman 1/C Samuel M. Taylor, USN
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

Robot Hand
Midshipman 1/C Todd A. Zirkle, USN
Adviser: Captain Charles B. McClelland, USMC

Systems Boat Competition
Midshipmen 1/C Michael J. Aden and
Tomas Carlos, USN
Adviser: Lieutenant Patrick D. Gardner, USN

Systems Boat Competition
Midshipmen 1/C William B. Allred, III and
Richard E. Kreh, Jr., USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

Systems Boat Competition
Midshipmen 1/C Anthony E. Arzu and
Joshua Lasky, USN
Adviser: Commander Michael F. Dulke, USN

Systems Boat Competition
Midshipmen 1/C Brent A. Beach and
Eric D. Valerga, USN
Adviser: Commander William H. Campbell, USN

Systems Boat Competition
Midshipmen 1/C Charles J. Bowser, III and
Kevin M. Kirin, USN
Adviser: Lieutenant Commander Charles O. Stephenson, USN

Systems Boat Competition
Midshipmen 1/C Roland V. Deguzman and
Robert C. Holloway, USN
Adviser: Lieutenant Commander Paul E. Thurman, USN

Systems Boat Competition
Midshipmen 1/C Daniel M. Emery and
Raymond A. Rivera, USN
Adviser: Commander John A. Hancock, USN

Systems Boat Competition
Midshipmen 1/C Kevin D. Glathar, Michael E. Sharp
and Kwang S. Yang, USN
Adviser: Lieutenant Commander Paul E. Thurman, USN

Systems Boat Competition
Midshipmen 1/C Karen M. Heine and
Paul W. Urbine, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Systems Boat Competition
Midshipmen 1/C Robert F. McGunnigle and
Jonathan W. Powell, USN
Adviser: Lieutenant Commander Charles O. Stephenson, USN

IR Control of Systems Boat
Midshipmen 1/C Kristine C. Burks and
Matthew W. Edwards, USN
Adviser: Lieutenant Dennis A. Maloney, USN

Systems Ball Competition
Midshipmen 1/C Charles B. Bassel and
Christopher A. Nash, USN
Adviser: Lieutenant Commander Richard J. McGraw, USN

Systems Ball Competition
Midshipmen 1/C Benjamin R. Cook and
Brian A. Montgomery, USN
Adviser: Commander John A. Hancock, USN

Systems Ball Competition
Midshipmen 1/C David M. Dutrow and
Frank C. Wittwer, USN
Adviser: Lieutenant Peter S. Allison, USN

Systems Ball Competition
Midshipmen 1/C William K. Haxton and
James P. McDonough, III, USN
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

Systems Ball Competition
Midshipmen 1/C Donald M. Hillergas and
David J. Yoder, USN
Adviser: Lieutenant Commander Richard J. McGraw,

Systems Ball Competition
Midshipmen 1/C Robert S. Koh and
Jonathan D. Sweeten, USN
Adviser: Commander William H. Campbell, USN

Systems Ball Competition
Midshipmen 1/C Erik S. Smith and
James B. Swanski, USN
Adviser: Lieutenant Commander Richard J. McGraw, USN

Publications

BECHERT, Thomas E., Associate Professor, "Analytical and Graphical Compensator Design Using the Inverse Frequency Response," Proceedings of the IASTD International Conference on Modelling and Simulation, The International Association of Science and Technology for Development, (May 1993), 325-328.

In a feedback control system, sensors determine the error signal between the plant output variables's desired value and its actual value. The compensator uses this error signal to generate actuating forces on the plant, to rapidly reduce the error signal toward zero. Using frequency domain design methods, the solution to the compensator design problem is represented by the frequency response function of the product of the compensator and the plant. This function must cross the unit circle at the phase margin angle at the crossover frequency. The design approach described in this paper separates the compensator function from the plan function. When the plant frequency response matches the inverse of the compensator frequency response, rotated to the phase margin angle, then the point of intersection of the two curves represents the solution to the compensator design problem. The technique is applied to several cascade compensator configuration and is extended to the case of feedback compensation.

BECHERT, Thomas E., Associate Professor, "Learning Modern Design Methods in the Undergraduate Control Systems Course," Proceedings of the Frontiers in Education Twenty-third Annual Conference: Engineering Education: Renewing America's Technology, Washington, DC, (November 1993), 632-635.

In a feedback control system, the control element generates actuating forces on the system "plant" in such a manner that the system output tracks changes in the system input with good accuracy and without excessive overshoot or oscillation. This paper deals with learning how to design a feedback control system so that it satisfies a set of performance specifications. Design is an iterative process of first modifying the control element and then comparing the resulting total system performance against the specifications. Further modifications are made until all specifications are satisfied. The students learn to design several different controller configurations, using both root locus and frequency domain approaches. Each student completes two major design projects, using these methods to find controllers which do indeed satisfy the performance specifications. They learn to plan a project with milestones and deadlines. They learn to take pride in their designs. They learn to justify their results by careful analysis and by preparing formal reports on their work. In spite of the hard work and long hours, most students look back on this design course with pleasure and pride.

CLEMENT, William I., Assistant Professor, "Use of Neural Networks in an Undergraduate Robotics Course," Proceedings of the 23rd Annual Conference on Frontiers in Education, Washington, D.C. (9 November 1993), 705-709.

The emphasis of artificial neural network study at the U.S. Naval Academy's Weapons and Systems Engineering Department is on thorough understanding of basic neural networks. Breadth is sacrificed for a more in-depth study. This paper discusses some of the insights

into artificial neural network learning which can aid in making smaller, more-robust neural network solutions.

CLEMENT, William I., Assistant Professor and Kenneth A. KNOWLES, Professor, "An Instructional Robotics and Machine Vision Laboratory," *IEEE Transactions on Education*, 37, 1, (February 1994), 87-90.

The U.S. Naval Academy has assembled a laboratory consisting of 16 identical stations in support of several robotics and machine vision courses. Each station has an 80486-based microcomputer, a five degree-of-freedom robot arm, a video-rate vision system, and a speech synthesis system. The robot arms are capable of teach-pendant operation or control via the attached computer. Programs written in the robot control language can be downloaded into, stored in, and run from robot RAM. For greater flexibility, move instructions can be generated by the controlling computer (in any desired computer language) and transmitted to the arm for execution via an RS-232 link. Each joint of the robot (plus the gripper) has a dedicated microprocessor for closed-loop servo operation utilizing incremental drive-motor shaft encoders and micro-switches for "home" locations. The vision system includes an RS170-compatible video camera, a PC-compatible frame grabber board, and a video monitor. This configuration permits the utilization of 2D and 3D vision feedback in the robot control process. The laboratory is used in support of undergraduate courses that cover such topics as robot kinematics and task planning, elementary machine vision, and artificial neural networks.

DWAN, Terrence E., Professor and BECHERT, Thomas E., Associate Professor, "Introducing Simulink into a Systems Engineering Curriculum," Proceedings of the Frontiers in Education Twenty-third Annual Conference: Engineering Education: Renewing America's Technology, Washington, D.C., (November 1993), 627-631.

Computer simulation of dynamic systems is a major component of systems engineering practice. SIMULINK is a versatile, user-friendly computer simulation program which is an extension of the powerful MATLAB interactive computational software package. In the model definition phase of a SIMULINK session, the design engineer uses a mouse to drag icons of systems components into the foreground window and then interconnects the components to form a flow diagram of the dynamic system. Dialog boxes provide a convenient means for defining parameter values for each block. In the model analysis phase, the engineer selects an

integration algorithm and other run-time parameters. During the simulation, key variables are observed as their values change with time. High quality reports are generated using MATLAB's powerful graphics capability. The paper describes examples of several simulations performed by the students. As an offering to potential users at other schools, the paper also includes guidance to the students regarding SIMULINK operation.

PRIGGE, Karl F., Midshipman 1/C, USN, Jerry W. WATTS, Associate Professor and Terrence E. DWAN, Professor, "Multi-Input, Multi-Output controllers for an Intercooled, Regenerated (ICR) Gas Turbine Engine," Proceedings of the IASTED International Conference on Modelling and Simulation, (1993), 348-341.

The design of a two variable controller for an advanced gas turbine engine using state space linear quadratic regulator (LQR) theory has been accomplished. The gas turbine engine has both an intercooler and a regenerator, and features variable stator vanes at the inlet of a free power turbine. This advanced engine is ideal for ship propulsion, and an engine of this type is being considered for future naval ship service. The LQR state space controller design was greatly simplified by modeling the engine in ACSL, an advanced computer simulation language. ACSL is compatible with another useful piece of software, MATLAB, which has routines for solving the LQR problem. It was necessary to reduce a 36 state model down to 8 states. The inputs to the eight state model are fuel flow and stator vane angle. The controlled variables are free power turbine shaft speed and turbine inlet temperature. Development of the controller by this method was aided by previous work using a state feedback pole placement and also by using a polyhedral search method.

PRIGGE, Karl F., Midshipman 1/C, USN, Terrence E. DWAN, Professor and Jerry W. WATTS, Associate Professor, "Design of a State Space Controller for an ICR Gas Turbine Engine," ASME Pamphlet 94-GT-374.

A multi-input, multi-output (MIMO) controller for an advanced gas turbine has been developed and tested using a computer simulation. The engine modeled is a two-and-one half spool gas turbine with both an intercooler and a regenerator. In addition, variable stator vanes are present in the free-power turbine. This advanced engine is proposed for future naval propulsion for both mechanical drive ships and electrical drive ships. The designed controller controls free-power turbine speed and turbine inlet temperature using fuel flow and angle of the stator vanes. The controller also has four

modes of operation to deal with over temperature and over speed conditions. An eight state reduced order controller was used with pole placement and LQR to arrive at control gains. Both methods required considerable insight into the problem. This insight was provided by previous experience with controller design for a less complicated engine, and also by use of a polyhedral search model of the engine. The difficulty with a MIMO controller was that both inputs affect both of the control variables. The classical resolution of this problem was to have one input control one variable at a fast time constant and the other input control the other variable at a slow time constant. The "optimal" resolution of this problem is analyzed using the transient curves and basic control theory.

PRIGGE, Karl F., Midshipman 1/C, USN, Jerry W. WATTS, Associate Professor and Terrence E. DWAN, Professor, "Optimal Controllers for an Intercooled, Regenerated (ICR) Gas Turbine Engine," The Proceedings of the 1993 Summer Computer Simulation Conference, (1993), 413-418.

A multi-input, multi-output controller has been designed for an innovative new gas turbine model, using the Advanced Continuous Simulation Language (ACSL), which is a high level simulation environment based on Fortran. A future high efficiency marine gas turbine is being developed with an intercooler, regeneration loop and variable stator vanes. These features have been incorporated into the model. Using special ACSL commands in conjunction with a high level computational engineering language, MATLAB, linear state space models were obtained. Optimal controllers were developed using state feedback as well as an iterative optimizing polyhedral search routine. Comparisons were made by examining system responses to a fixed on-load, off-load transient profile.

WATTS, Jerry, Associate Professor, URBACH, Herman B., GARMAN, Richard W., Donald T. KNAUSS, Terrence E. DWAN, Professor, E. Eugene MITCHELL, Professor, Cory HOWES, Ensign, USN, "A Steam-Augmented Gas Turbine with Reheat Combustor for Surface Ships" Proceedings of the IX Annual Simulators Conference, 16, 3, (May 1994), 475-481.

The steam-augmented gas turbine (SAGT) concept has attracted attention because of its benign level of NO_x emission, its increased fuel efficiency, and significant, cost-effective increments of output power, particularly when moisture injection is increased to levels approaching 50% of air flow. Such high levels of

moisture consumption distinguish the SAGT engine from commercial steam-injected gas turbines where steam flow may be less than 15% of air flow. At the high 50% levels, the SAGT burner would operate near stoichiometric combustion ratios with specific power exceeding 570 hp-sec/lb.

A newer SAGT engine concept, described herein, dispenses with the intercooler, but adds a low pressure reheat combustor. At the most efficient operating points, the efficiency of this new reheat SAGT engine at 43% exceeds the efficiency of the ICR engine, while exhibiting the compactness of the previous SAGT concept. Tabular and graphical simulation data comparing the baseline engine, with the ICR and other engine simulations, show that the maximum efficiency of the new SAGT engine occurs at power required for cruising speeds. Since a DDG operates near cruise conditions for the majority of its mission time, a SAGT plant uses less fuel than the ICR plant. Moreover, since it eliminates the intercooler, developmental work on member element, largely derivable from off-the-shelf components, is reduced. Even with conservative cost estimates, the SAGT plant is quite competitive on a first-acquisition cost basis with the current gas turbine in the Fleet.

WICK, Carl E., Assistant Professor, Murray H. Loew and Joseph Kurantsin-Mills, The George Washington University, "Understanding Microvessels in Two and Three Dimensions" in *Handbook of Pattern Recognition and Computer Vision*, C. H. Chen, C. F. Pau and P.S.P. Wang eds., Singapore: World Scientific Publishing Co., (1993), 667-693.

A chapter in the Handbook of Pattern Recognition and Computer Vision discusses a model that replicates the illumination and reflection processes which result in a film or video image of the blood vessels of the human conjunctiva. The model provides a foundation for the development of detection algorithms, for precise measurement of vessel dimensions and depth within a diffuse medium, and for separating neighboring vessels in complex scenes. The model is validated through a series of experiments using actual conjunctiva images and a specially constructed phantom representing the structure of the conjunctiva, but having known dimensions and properties.

WICK, Carl Eric., Assistant Professor, *A Model-Based Approach to the Detection and Tracking of Microvessels in Bulbar Conjunctiva Images*, Dissertation, The George Washington University, (30 September 1993).

This dissertation reports on research toward the

development of an imaging system that is capable of detecting, tracking and reporting morphological parameters about the blood vessels seen in photographic images of the human conjunctiva. The work begins with the development of a comprehensive mathematical model that describes all the known illumination and reflection effects which may occur along the optical path from light source to camera. The model is then used to develop methods for precisely measuring the centers, widths and relative depths of blood vessels in translucent tissue. The measurements are then used in algorithms derived from fuzzy logic techniques to detect blood vessels and to track the paths of those found. Examples of the technique applied to actual conjunctiva images are shown.

WICK, Carl E., Assistant Professor, Murray H. Loew and Joseph Kurantsin-Mills, The George Washington University, "Modeling of Illumination Effects for Image Processing of Microvessels", *Proceedings SPIE Medical Imaging 1993: Image Capture. Formatting and Display*, Yougmin Kim ed., (1993), 35 46.

This paper reports on the first phase of the development of an image processing system that is capable of detecting and tracking blood vessels in photographs or video images of the human microcirculation. Described is a completed mathematical model of the illumination processes contributing to a film or video image of the human bulbar conjunctiva. The model is based on a cylindrical vessel embedded in a diffuse medium that is on a reflecting background. Fundamental physical principles, which include Lambert's cosine law, isotropic spreading, Fresnel's law and Beer's law were systematically applied to the model. A video apparatus and a phantom were constructed to analyze different illumination conditions and to verify the model. A simulation based on the model was shown to compare favorably with data taken from images of the phantom.

WICK, Carl E., Assistant Professor,"A Four-Chip Microcomputer for Undergraduate Engineering Courses", *Proceedings Frontiers in Education*, Laurence P. Grayson ed., (November 1993), 578-582.

This paper reports on the design of a simple microcomputer system and its use in teaching initial embedded computer concepts in systems engineering classes at the United States Naval Academy. The system was designed as a way of helping Systems Engineering students develop some intuition about how and why digital computers are used as embedded elements in modern control systems. The only interaction that many students have had with a microprocessor is as a personal computer. A PC, however, hides the capabilities of a microprocessor as a control element. Consequently, many find it difficult to understand how this device can be used for anything other than as a computational tool. This simple microcontroller system has been very effective in allowing students to see the low-level functions of a modern embedded microcontroller and to get some hands-on experience using a computer as a system controlling element.

Presentations

BECHERT, Thomas E., "Learning Modern Design Methods in the Undergraduate Control Systems Course," Frontiers in Education Twenty-third Annual Conference: Engineering Education: Renewing America's Technology, Washington, DC, 9 November 1993.

CLEMENT, William I., Assistant Professor, "Use of Neural Networks in an Undergraduate Robotics Course," Frontiers in Education Conference, Washington, DC, 9 November 1993.

CLEMENT, William I., Assistant Professor and Kenneth A. KNOWLES, Professor, "Machine Vision Workshop," Baltimore/Washington Chapter of Robotics International of the Society of Manufacturing Engineers (RI/SME), 24 March 1994.

CLEMENT, William I., Assistant Professor and Kenneth A. KNOWLES, Professor, "Theory and Applications of Machine Vision for Image Enhancement and Pattern Recognition," AI Group at Aberdeen Proving Grounds, Aberdeen, Maryland, 23 May 1994.

DWAN, Terrence E., Professor and Thomas E. BECHERT, Associate Professor, "On Introducing Simulink into a Systems Engineering Curriculum," Frontiers in Education, Washington, DC, 6 November 1993.

DWAN, Terrence E., E. Eugene MITCHELL Professors, Jerry W. WATTS, Associate Professor, Herman B. Urbach and Richard W. Garman, "A Steam-Augmented Gas Turbine Model," 1994 Simulation MultiConference (SMC) sponsored by SCS, LaJolla, California, 10-14 April 1994.

PRIGGE, Karl F., Midshipman 1/C, Jerry W. WATTS, Associate Professor, and Terrence E. DWAN, Professor, "Design of a State Space Controller for and Advanced Gas Turbine Engine," 1993 Summer Computer Simulation Conference, Boston, Massachusetts, July 1993.

PRIGGE, Karl F., Midshipman 1/C, Jerry W. WATTS, Associate Professor, and Terrence E. DWAN, Professor, "Design of a State Space Controller for an Intercooled Regenerated (ICR) Gas Turbine Engine," ASME Turbo Expo '94, The Hague, The Netherlands Congress Center, 13 June 1994.

RASK, Olaf N., Associate Professor, "An Undergraduate Course in Composite Materials at the U.S. Naval Academy," Conference on Frontiers in Education, Washington, DC, 6-9 November 1993.

URBACH, Herman B., Richard W. Garman, Jerry W. Watts, Associate Professor, Terrence E. Dwan, E. Eugene Mitchell, Professors and Cory Howes, Ensign, USN, "Steam-Augmented Gas Turbine With Reheat Combustion for Surface Ships," 1994 Simulation Multiconference, San Diego, California, 10-15 April 1994.

URBACH, Herman B., Richard W. Garman, Donald T. Knauss, Jerry W. Watts, Associate Professor, Terrence E. Dwan, E. Eugene Mitchell, Professors and Cory Howes,Ensign, USN, "A Steam Augmented Gas Turbine with Reheat Combustor for Surface Ship," ASNE Conference, Washington, DC, 27 April 1994.

WATTS, Jerry W., Associate Professor, E. Eugene MITCHELL, and Terrence E. DWAN, Professors, "Improved Efficiency and Power Burst in a Gas Turbine Engine.", IASTED Conference, Modeling and Simulation, 1-4 May 1994, Pittsburgh, Pennsylvania.

WATTS, Jerry W., Associate Professor, Terrence E. DWAN and E. Eugene MITCHELL, Professors, "Improved Efficiency and Power Burst in a Gas Turbine Engine," IASTED International Conference, Modelling and Simulation, Pittsburgh, Pennsylvania, 3 May 1994.

WICK, Carl E., Assistant Professor, Murray H. Loew and Joseph Kurantsin-Mills, The George Washington University, "Detecting and Tracking Microvessels in Conjunctiva Images: An Approach Based on Modeling and Fuzzy Logic," at SPIE Medical Imaging 1994 Conference, Newport Beach, California, 17 February 1994.

WICK, Carl Eric, Assistant Professor, "A Model-Based Approach to the Detection and Tracking of Microvessels in Bulbar Conjunctiva Images," Dissertation defense, The George Washington University, Washington, DC, 25 June 1993.

WICK, Carl E., Assistant Professor, "A Four-Chip Microcomputer for Undergraduate Engineering Courses", Frontiers in Education Conference, Washington, DC, 8 November 1993.

Division of
Humanities and Social Sciences

Colonel Michael Glynn, USMC
Director

Economics

Professor Rae Jean B. Goodman
Chair

The Economics Department faculty have been involved in a variety of scholarly and professional activities this year. Assistant Professor Karen Thierfelder presented five conference papers focussing on the North American Free Trade Agreement and its implications for U.S.-Mexican trade and potential agricultural policy changes in both countries, and on Bangladesh labor market policy implications for income distribution. Assistant Professor Ksenia Kulchycky presented two conference papers on multinationals and international direct investment. Professors Little and Fredland presented a paper on Defense Contractor profitability at the InterUniversity Seminar on Armed Forces and Society. Professor Little presented a conference paper on Congressional voting on defense issues. Professor Bowman's work on training programs for economically disadvantaged adults culminated in three reports.

Professors Little and Fredland organized a major conference on the all-volunteer force entitled "A Military of Volunteers: Yesterday, Today and Tomorrow." The conference was jointly sponsored by the U.S. Naval Academy and the Office of the Secretary of Defense (Personnel and Readiness). The conference brought together academics, analysts, policymakers and other interested people on the 20th anniversary of the end of the draft. The conference continues the department emphasis on defense related research. As further evidence of outside support for this area of research, General Dynamics Corporation provided funding to the Naval Academy Alumni Association to endow the Admiral William J. Crowe Chair of Economics of the Defense Industrial Base. The position will be non-tenured with the holder involved in defense related research and responsible for developing a Defense Industrial base course. The Department expects to fill the Chair by August 1994.

Four midshipmen completed significant research projects under faculty tutelage. Midshipmen Lewis Rhodes completed the Trident Scholar Program with his paper entitled "A Study of the Effect of the North American Free Trade Agreement upon Foreign Investment in Mexico and the Resulting Effect upon Mexico's Trade with the United States." The midshipmen in the Honors Program investigated a wide range of economics issues and presented the research results to faculty seminars. Douglas C. Campbell's research focused on baseball players; his final paper was entitled "Performance and Pay in Baseball: An Analysis of On-Field Performance and Salaries." Donald J. West continued his interest in labor economics and wrote the paper "Military Experience and Training Effects on Civilian Wages." Joe Neo's "Retention and Promotion of Navy Pilots" evolved out of his interests in military manpower issues stimulated by the Labor Economics and Defense Economics courses. In addition to these four midshipmen, each economics major must complete a research project during the final semester. Scholarly activity continues to enrich the professional lives and teaching effectiveness of faculty with the publication of five articles, two book reviews, and three reports.

Sponsored Research

The Differential Effects of Foreign and Domestic Takeovers on U.S. Firms

Researcher: Assistant Professor Ksenia M. Kulchycky
Sponsor: Naval Academy Research Council (OMN)

This paper is an analysis of the effects of foreign takeovers of U.S. firms on the operations of those firms. The recent growth in foreign takeovers of American firms has led to many anxious comments in the press, various proposals for registration provisions, and other legislative proposals for restrictions.

Fear of foreign takeovers includes anxiety over excessive foreign influence on our economic and political system. Many also fear foreign acquisition of proprietary technology and shifting of Research and Development investment away from the U.S., thereby eroding U.S. competitiveness, reducing employment and skill levels of workers, and transfer of high-tech, high value-added, components of production away from the U.S.. Despite the concern regarding foreign takeovers, there has been little research done on their effects.

The theoretical model is being developed and the time consuming process of data gathering is being done. The National Bureau of Economic Research helped sponsor this project.

Toward Resolving the Tension Between Theory and Fact: The Determinants of International Direct Investment and Trade

Researcher: Assistant Professor Ksenia M. Kulchycky
Sponsor: Naval Academy Research Council (OMN)

The objective of this research is to resolve the contradictions between the theoretical and empirical literature of direct investment. Most of the theoretical literature predicts that direct investment is attracted by differences in relative factor endowments between countries. The empirical literature shows that direct investment is attracted to economies similarly endowed to its parent country. The model developed in this paper proposes that these contradictions result from inadequate theoretical and empirical analysis of internalization.

An empirical analysis of the Kulchycky model, which merges internalization and location choice issues of direct investment, is conducted. Tobit and Logit analyses were used to determine whether the new modeling of direct investment was supported by the data. This research was also sponsored by the National Bureau of Economic Research.

A Study of the Effects of the North American Free Trade Agreement upon Foreign Investment in Mexico and the Resulting Effect upon Mexico's Trade with the United States

Researcher: Midshipman 1/C Lewis P. Rhodes, USN
Adviser: Assistant Professor Karen E. Thierfelder
Sponsor: Trident Scholar Program

In addition to the immediate benefits of trade liberalization, Mexico anticipates an increase in foreign investment due to the passage of the North American Free Trade Agreement (NAFTA). The agreement signals the Mexican government's commitment to free market economics, suggesting a favorable climate for investors.

Mexico hopes to attract foreign capital to develop its economy. Since over 70% of Mexico's imports come from the U.S., there are long run benefits to the U.S. as Mexico's income grows.

To estimate the long run impact of NAFTA, this project will forecast the changes in investment due to

NAFTA using a regression equation. To estimate the impact of investment changes on Mexico's income and consumption of U.S. goods, the investment forecasts will be used in a computable general equilibrium (CGE) model of the United States. Given the increase in Mexico's capital stock, the model will indicate sectoral changes in output, employment, and trade in both countries. This simulation approximates the dynamic effects of NAFTA. While it does not indicate the transition path to the long run with an increased capital stock, it does indicate the changes in both economies as a result of the capital changes. It will suggest the benefits of NAFTA to the U.S. economy in the long run. The results will be compared to the short run changes of NAFTA following trade liberalization in both countries.

North American Free Trade Agreement, Mexican Agricultural Policy Reform, and Labor Mobility

Researcher: Assistant Professor Karen E. Thierfelder
Sponsor: Naval Academy Research Council, (OMN)

Mexico is removing agricultural trade protection under the North American Free Trade Agreement and revising its domestic support to agriculture under the PROCAMPO program. Each policy shock will dramatically change Mexico's agricultural output and employment, as well as migration pressure. Following trade liberalization, increased competition from U.S. agricultural producers will affect Mexican rural labor markets. Displacement of agricultural workers will lead to migration from rural areas to urban areas in Mexico and increased migration to the U.S. However, as Mexico attracts investment, jobs will be created, mitigating migration pressure. PROCAMPO also will introduce adjustments in agriculture as input supports and guaranteed prices for corn and beans are eliminated and a temporary income transfer program is introduced to offset the initial income losses. This paper evaluates the policy interaction, focusing on migration and agricultural output in Mexico. A major issue is the potential for the PROCAMPO program to serve as a transition policy until the long run beneficial impact of NAFTA is felt. Migration and agricultural output changes in Mexico are quite sensitive to the farmers' reaction to the income transfer. If farmers view the transfer as a supplement to agricultural income, and therefore decide not to migrate, the PROCAMPO program can successfully ease the adjustment problems in Mexican agriculture. This research is being conducted along with Sherman Robinson, International Food Policy Research Institute, and Mary Burfisher, U.S. Department of Agriculture.

This paper is forthcoming in a volume of conference proceedings from the International Agricultural Research Consortium's Winter Meetings; it is an extension of work done under NARC.

North American Free Trade Agreement and Transition Scenarios under Mexico's Agricultural Policy Reform

Researcher: Assistant Professor Karen E. Thierfelder
Sponsor: Naval Academy Research Council, (OMN)

Mexico is currently changing its domestic agricultural policies. The government will replace its current system of market intervention with an income transfer scheme. The policy, PROCAMPO, is designed to ease the farmer's adjustment to market prices as input subsidies, tariffs, quotas, and domestic price supports are eliminated. Farmers may react to the income transfers in two ways. They may view the income as a windfall gain and decide to leave farming. Or, they may remain in agriculture and use the income transfer to invest in infrastructure, irrigation, and new capital. Each response will have a dramatically different impact on farm output and migration. This research analyzes responses to the income transfer. The longer run impact of NAFTA is also considered, assuming an increase in Mexico's capital stock under the alternative transition scenarios. This research is being conducted along with Sherman Robinson, International Food Policy Research Institute, and Mary Burfisher, U.S. Department of Agriculture.

Independent Research

Pacific Basin Direct Investment in the U.S.

Researcher: Assistant Professor Ksenia M. Kulchycky

This research conducted with the National Bureau of Economic Research, compared and contrasted foreign direct investment in the U.S. based on country of foreign owner. There has been a great deal of concern in recent years over Japanese direct investment in the United States. Japanese investment stirs much greater fears than, for example, the much greater presence of U.K. ownership of U.S. assets. This research investigates whether there is any real cause for this concern. Is there anything truly different about Japanese, or perhaps other Pacific Basin Investment that should have the U.S. more concerned about it than about investment from other countries?

Some of the accusations against Japanese direct investment include that Japanese affiliates import more from the home country that other foreign owned firms. This has been of particular concern to U.S. automobile component suppliers. There is also concern that Japanese firms paid high Research and Development firms for their technical expertise and patents and then move high skilled, high paying jobs abroad, and that

Japanese and other Pacific Basin country parents do not pay their fair share of U.S. corporate taxes by particularly pernicious manipulation of income reporting.

All of these issues were addressed using individual firm observations for foreign direct investment in the U.S. This has not previously been done, partly because of difficulty accessing firm-level data from the Bureau of Economic Analysis (B.E.A.). Usually, access is granted only to industry-level data. This unique access allowed this study to look in much greater detail at foreign activity in the U.S.. Regression analysis was used.

The results suggest that Japanese and other Pacific Basin U.S. affiliates have higher imports intensities than U.S. Affiliates of other foreign parents. There is no clear evidence so far that this behavior is changing as Japanese investment ages. Japanese and other Pacific Basin affiliates also reported much lower profits, even allowing for a large number of firm and industry characteristics. Further, Japanese affiliate seemed to have higher R&D intensities even allowing for the large number of firm and industry characteristics.

Taxes, Income, and Foreign Direct Investment

Researcher: Assistant Professor Ksenia M. Kulchycky

Expanding on the previous analysis which focused on the issues of tax effects on profit shifting by U.S. Multinationals, this study will focus on the effects of taxes on the distribution of real assets such as employment and productive capacity. The issues are somewhat different here and this paper will involve a reformulation of the model used in last year's paper.

Regression analysis will again be used to test the

implications of the model with additional variables and a more recent and expanded data set. The statistical analysis has not been conducted yet due to access problems at the Bureau of Economic Analyses which should be resolved soon.

This research project is underdevelopment and includes theoretical and statistical analysis. Data is being gathered, and preliminary regressions have been run.

Defense Contractor Profitability and Tobin's q

Researchers: Professors J. Eric Fredland and Roger D. Little

This project is a continuation of research begun two years ago under the sponsorship of the Defense Systems Management College. That project had argued that profitability of major defense contractors is apparently

driven by the size of procurement budgets and by Defense Department policy regulating profit that can be earned by firms doing defense business. On that basis, the extent to which these factors -- procurement budget

size and profit policy -- reflected in financial market assessments of these firms was examined. The analytical tool used was the q ratio, first developed by James Tobin and now widely used as a measure of monopoly power and as an approach to measuring the relationship between financial markets and capital investment. It is the ratio of market value of the firm to the replacement cost of its capital stock. In theory, when the q exceeds one, investment in new capital enhances market value. If a firm is in a competitive industry, q will tend to move to unity as entry and/or expansion leads to exploitation of available investment opportunities. In an industry with significant barriers to entry, however, q will tend to exceed one, reflecting the existence of monopoly profits. Defense contractors operate in an environment with

significant entry barriers. Their profitability is potentially subject to sharp fluctuation, however, when budgets change and perhaps when Defense Department policy regarding contractor profit changes. If these changes in fact affect profitability to any great degree, they should be reflected in fluctuations in the q ratio. The COMPUSTAT data base, which contains financial data on more than 3000 firms over a 30 year period, was used to carry out this effort. The research continued with an expansion of the data base and a search for appropriate tools of analysis for handling our time series-cross section data. This effort resulted in a paper presented at the Inter-University Seminar on Armed Forces in Society meeting in October.

Employment-Based Social Accounting Matrices for Rural Development Analysis

Researcher: Associate Professor Arthur Gibb, Jr.

This research explores the possibility of constructing a Social Accounting Matrix (SAM) for a rural micro-region using employment data as the basis for generating a full set of income and expenditure estimates. For many issues of rural-urban linkage analysis the pressing need is for a more detailed understanding of structure rather than behavior, the latter being fairly well understood by now.

The research is based on the empirical evidence generated by a rural-urban linkages study in a micro-region of Central Luzon in the early 1970s. The basic argument is that the rural economy is relatively simple and permits simplifications identifying skill levels, capital

use, and capital origin with particular production activities. It further permits production activities to be identified with the production, consumption, and public service linkages to agriculture. A crucial cross-classification is whether activities are full-time or part-time.

An initial version of the SAM has been estimated. A Tempory Active Duty Ensign helped with putting it into a spreadsheet file. The SAM will subsequently be subjected to various consistency tests, especially comparing its results to those of other regional SAMs.

The Teaching Requirements of General Education Courses

Researcher: Associate Professor Arthur Gibb, Jr.

In this research a number of reports have been prepared over the past few years on the purposes, content, and teaching needs of our general education offerings.

A paper, "Back to Basics: Course Design at the Introductory Level", was presented at the Eastern Economics Association annual meeting in March. It defined an "introductory economics" approach, in juxtaposition to the typical "principles of economic analysis" approach to course design. This approach was also argued within the Department--the argument was instrumental in the decision to offer an experimental introductory economics course (FE485) in the Fall of 1994.

A number of items of teaching materials--with suggested approaches for their use--were circulated among the faculty. (These included a Classical/Keynesian circular flow diagram kit, an adjustment mechanism handout for the National Income multiplier, an "initial description" handouts and a handout on U.S. economic history). These were intended as examples of how materials and approaches might be exchanged among those teaching FE 210, in the interest of not only providing new instructors with a variety of relevant material to draw on, but also of identifying particularly apt items which might from time to time be adopted for general use.

Other memoranda prepared in this effort addressed the question of how to attract non-majors, the possibility of identifying a "global economics" set of 300-level courses,and criteria for textbook selection.

Examination Performance and Incentives

Researchers: Professor Rae Jean B. Goodman and Associate Professor Thomas A. Zak

The fundamental hypothesis of this study is that providing a monetary incentive stimulates student performance on a standardized exam. The data used for the analysis are the performances of first class economics majors on the Major Field Achievement Test for the 1989-1991 period. The experimental setup was to divide the class into separate classrooms matching the academic quality of the two rooms by Quality Point Ration (QPR) rank. As students entered the "incentive" room they were given a memorandum which informed them that there were monetary prizes for the top three performers by four QPR groupings. The students in the other room received the same memorandum as they exited the exam. The empirical analysis test the hypothesis holding ability measures constant. The ability measures include economics QPR, overall QPR, Scholastic Aptitude Test (SAT) scores, performance in intermediate macroeconomics and microeconomics courses, numbers of economics courses completed, etc. The analysis has not been completed; however, the plan is to complete the research during the intercessional period.

Regional Foundations of the First Industrial Revolution

Researcher: Professor Clair E. Morris

This research continues the work started with a sabbatical grant in academic year 1992-93, which was directed toward exploring the regional foundations of the first industrial revolution that got underway in England around 1760. During the fall of 1992, many industrial museums and restored manufacturing plants were visited in the British towns of Manchester, Liverpool, Bradford, Leeds, and Sheffield. Many notes were taken and much archival material was acquired which provided a substantial basis for drawing conclusions about why that particular area came to be the site of the first advance in mechanized manufacturing. The focus is on the nature and character of the area, the people, and the previously existing economic activity. Much research continues to be needed in order to get the data in good form for the purpose of developing a paper that could be presented to a professional conference. The intent is to continue this work during the summer of 1994.

Policy Noise around the North American Free Trade Agreement: The Effects on Concurrent North American Foreign Trade Agreement, General Agreement on Tariffs and Trade, and United States Farm Policy Reform

Researcher: Assistant Professor Karen E. Thierfelder

The United States and Mexico are negotiating the liberalization of U.S.-Mexican agricultural trade in a North American Free Trade Agreement (NAFTA) in the context of important, simultaneous global and U.S. policy shifts. One element of the "policy noise" surrounding the NAFTA is the multilateral reduction of agricultural support and protection under negotiation in the Uruguay round of the General Agreement on Tariffs and Trade (GATT). A second is a possible unilateral reduction in U.S. farm support as part of the fiscal deficit reduction effort. Each of these policy shocks has potentially important interactions with the effects of the NAFTA on U.S. and Mexican agriculture.

This paper analyzes the effects of the North American Free Trade Agreement (NAFTA) on U.S. and Mexican agriculture in the context of two concurrent policy shocks: multilateral agricultural policy liberalization under the GATT, and a unilateral reduction in U.S. farm support. The analysis uses a three-country, computable general equilibrium (CGE) model, which

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simulates the trade links between the U.S. and Mexico. Results indicate that NAFTA and multilateral liberalization under the GATT have countervailing effects: NAFTA reduces U.S. agricultural contraction under GATT, and GATT reform ameliorates the contraction in some Mexican farm sectors, particularly food grains and corn, under NAFTA. Reduced U.S. farm support makes endogenous Mexican import quotas less binding, implying that U.S. program reform can reduce the adjustment cost of trade liberalization in Mexico. This

research is being conducted with Sherman Robinson, International Food Policy Research Institute, and Mary Burfisher, U.S. Department of Agriculture.

This paper was presented at the American Agricultural Economics Association in August, 1993. A modification of the computer simulations to better represent U.S. policy reform has been completed. The next step is a revision of the paper and then its submission to a journal.

Labor Market Policies and the Distribution of Income in Bangladesh

Researcher: Assistant Professor Karen E. Thierfelder

A perennial puzzle in development literature is why low-wage countries like Bangladesh seem to achieve rapid export-led growth. A standard answer to the puzzle is that labor markets in such countries are inflexible precisely because the country is so poor: labor market distortions act as "safety nets" when more precise targeting is infeasible. This research examines the latter proposal using a general-equilibrium model of Bangladesh. First, the study investigates whether existing labor market policies -- such as the minimum wage law or "food-for-work" schemes -- do in fact, protect the poor. Next, for those policies that do, an

examination of whether there exists alternative policies which achieve the same income-distribution goals while improving the flexibility of the economy is made. Finally, the study evaluates the costs of labor-market rigidity by simulating trade liberalization in Bangladesh under alternative policies for protecting the poor through labor market interventions. This research is being conducted along with Shantayanan Devarajan, The World Bank and Hafez Ghanem, The World Bank.

This paper will be a chapter in a study on labor markets in Bangladesh. It will also be submitted to the World Bank Development Report.

Trade and Employment in General Equilibrium

Researcher: Assistant Professor Karen E. Thierfelder

When constructing an applied computable general equilibrium (CGE) model, one must account for the wage differentials apparent in the base data set. Traditionally, observed wage differentials are included as exogenous, sector specific, mark-ups over the competitive wage. While this treatment accurately represents the observed data, it does not include behavioral differences that the wage differentials can represent. Instead, an exogenous wage differential indicates that labor is more productive in certain sectors than it is in others. Due to the model construction, welfare will improve when the high wage sectors expand.

When one includes the behavior that gives rise to a differential by sector, the wage differential becomes endogenous. Two explanations for sectoral wage

differentials--efficiency wage theory and union behavior-- will be explored in this paper. While both views of the labor market account for the observed wage differential, each reflects vastly different behavior in the labor market and in the producer's optimization decision. This study shall show that the magnitude, and even the direction of resource movements between sectors, in response to a tariff or other tax change, greatly depends on how inter-industry wage differentials respond. In other words, the choice between exogenous differentials, efficiency wage, or union behavior, may significantly affect the positive and normative conclusions drawn from CGE model simulations of trade and industrial policy.

This research is being conducted along with Clinton Shiells, International Monetary Fund.

Research Course Projects

Performance and Pay in Baseball:
An Analysis of On Field Performance and Salaries

Researcher: Midshipman 1/C Douglas C. Campbell, USN
Adviser: Associate Professor Thomas A. Zak

Rapidly increasing player salaries call into question whether major league baseball players are "worth" what they are paid. In particular, do players contribute revenues to their teams sufficient to cover their salaries? This paper estimates the effect individual players have on team revenues and examines if the highest paid players are earning their salaries. The first step is to estimate a production function for major league baseball teams. Using data from 1986-1992, the impact of a wide range of offensive (batting and base running) and defensive (pitching and fielding) inputs on winning is determined.

Although this equation is itself interesting because it details the relative importance of different inputs in determining a team's success, one must also consider the effect that winning has on a team's revenues before one can compute an individual player's marginal revenue product. Empirically, the results of this paper suggest that baseball players are not, in fact, overpaid. Owners continue to pay higher salaries because most players contribute more revenue to the team than they are being paid.

Retention & Promotion of Navy Pilots

Researcher: Midshipman 1/C Joseph H. Neo, USN
Adviser: Professor William R. Bowman

The objective of the research to determine if there is any statistical relationship between pre-commissioning educational experiences and naval retention and promotion patterns of Academy graduates compared to Reserve Officer Candidate (ROTC) and Officer Candidate School (OCS) graduates in the Pilot community.

The data used for the analysis comes from the 1980 - 1990 Officer Master Files compiled at the Lieutenant (LT) and Lieutenant Commander (LCDR) selection board years, along with the Officer Loss files over this same period. Nearly 4,000 pilots were identified in the data and roughly 3,500 had complete data on academic majors, curriculum, and grades.

After many attempts to specify different measures

of academic experience, the study found that the only major relationship that was statistically significant existed between over-all grades and promotion to LCDR, in addition to accessions source differences and retention behavior. Graduates with higher academic grades were more likely to be promoted and the propensity to stay to the LCDR boards (years of service between 8 and 10) were highest among Academy graduates, then ROTC, and finally OCS. Technical and math curriculum in general were not statistically significant predictors of officer experience in this community.

The findings support the current Academy policy of service selection based mainly upon grades as opposed to giving a preference to those from more technically oriented academic majors.

Military Experience and Training Effects on Civilian Wages

Researcher: Midshipman 1/C Donald J. West, USN
Adviser: Professor Roger D. Little

Within the last twenty years or so, a large amount of research has attempted to quantify the effects of military service on civilian earnings. The findings have generally

shown that while service in the military initially depresses civilian wages as veterans attempt to catch up to their civilian counterparts, the skills received in military

training make the transition easier and in fact add value to the individuals's human capital.

The research tended to confirm what earlier studies had shown concerning civilian earnings of veterans, however, with the addition of the QUIT variable (leaving the service before completion of obligation) and a further racial breakdown to study military tenure and training, some interesting trends were observed. QUIT, as we expected, imposed penalties on a veteran's later civilian earnings, either by signaling a poor performer or indicating some physical disability. Likewise, the black interactive variables indicated that blacks tend to benefit more from military training than the general population of veterans. While much improvement can be made, these findings seem reasonable, based on prior research.

The majority of new enlistees in the military join for any number of different reasons. However, almost all of these individuals believe that military service will provide them with certain benefits upon returning to the civilian sector. Based on this research, the military truly is "a great place to start."

Publications

BOWMAN, William R., Professor, "Evaluating Training Programs for Economically Disadvantaged Adults," Research Report 92-90, National Commission for employment Policy, Washington DC, (June 1993).

Since the Job Training Partnership Act (JTPA) was first enacted a decade ago, relatively few states have evaluated the effectiveness of the training activities in improving adult participants' likelihood of employment, and increasing their earnings if they are employed. State-level evaluations are particularly important since states have major responsibilities for managing the JTPA programs and for establishing policies which affect the operation and performance of Service Delivery Areas.

A few states have undertaken non-experimental evaluations of their programs: a comparison of the employment and earnings of JTPA participants after they left the program with employment and earnings of a comparison group who did not enroll in JTPA. Data on earnings are obtained from Unemployment Insurance (UI) wage records. For the most part, however, states have relied on descriptive data on post-program outcomes to assess the effectiveness of their programs. This approach can produce misleading results, as this report indicates.

The report has produced two major findings. First, states need not rely on descriptive information to assess JTPA's effectiveness. It is feasible to use UI wage-record data and non-experimental techniques to evaluate JTPA programs for the economically disadvantaged adults. The second major finding is that non-experiment techniques produce results on post-program outcomes that are highly relevant to policy makers.

In contrast to a recently completed national experimental study of JTPA adults, the results from this experimental study indicate that JTPA training is an effective strategy to assist economically disadvantaged adults. On one hand, the national experiment results are flawed and the causes of the design flaws are detailed in this study. On the other hand, this non-experimental study found positive employment and earnings improvements among JTPA participants. Adult male participants enrolled in occupational classroom training and on-the-job training experienced a greater likelihood of being employed after one year following training than similar adult males of the comparison group. Adult female participants also benefitted from JTPA training. Those enrolled in on-the-job training were found to be more likely to be employed, and if employed to earn more than those in the comparison group; those enrolled in classroom training were found to experience higher earnings than similar adult females in the comparison group.

The report proved strong encouragement to states desiring to evaluate their JTPA programs. It also provides important information on the effectiveness of JTPA programs for improving the labor market position of economically disadvantaged adults.

BOWMAN, William R., Professor, "An Analysis of the Relative Impacts of Employment and Training Programs for Economically Disadvantaged Adults in Oregon, report completed for the Oregon JTPA Administration, (July 1993).

An evaluation of Job Training Partnership Act (JTPA) employment and training programs has always been an inherent part of the joint public-private effort since the program's inception. To date, the vast majority of evaluations have measured the ability of Service Delivery Areas (SDAs) to meet flexible national performance standards tailored to the eligible clientele served and the

local economic conditions that characterize the market area. Little headway has been made regarding more extensive program evaluation, based upon individual data of JTPA participants across individual states, however. This study is intended to help fill this knowledge gap for Oregon.

Whereas performance standard auditing efforts can at best determine the relative performance of SDAs across a state, the research undertaken in this study addresses the more fundamental issue of *why* some participants "do better" than others; distinguishing between program intervention effects from client and local economic effects external to JTPA management.

The primary findings of this study relevant to JTPA program performance in Oregon, include the following:

Immediate job placement is the strongest predictor of who will be more likely to be employed up to two years later, and employed at higher earnings levels.

Oregon's JTPA programs are training a majority of economically disadvantaged adults in occupations in demand and placing program completers in firms offering employment security and career advancement.

Of all types of training activities, On-the-Job Training (OJT) programs appears to be a cost-effective alternative for both adult men and women. In particular, OJT increases the likelihood of employment by one month per year for men and women, and to raise annual earnings by $900 for women -- compared to other types of training.

Occupational Specific Classroom Training (CT-OS) proves no more effective than Job Search Assistance (JSA), even after controlling for the different types of clients served between the two training alternatives: With relatively lower training costs, JSA is more cost-effective.

The unique two year follow-up period used in the study is instructive for JTPA evaluation. First, the study shows the JTPA administrative 13-week follow-up survey is strongly biased upwards -- those responding are far more likely to be employed and employed at higher earnings than those failing to respond. Second, the Unemployment Insurance (UI) administrative files compiled for all covered workers in Oregon each quarter are a readily available and inexpensive data source that can be used to evaluate both short-term and longer term performance outcomes of the population of clients served by JTPA each year.

The data base used in this study and the research methodology followed represent continued improvements in the evaluation of Oregon's employment and training efforts to improve the quality of workers in an expanding, ever-changing, and more highly competitive labor

market. Other state efforts to develop new performance standards for JTPA and an improved, more comprehensive index of worker quality should be used along with this study to provide state officials with a more comprehensive picture of the quality work force that has come to characterize Oregon.

BOWMAN, William R., Professor, "Performance Standards Adjustments Based Upon State-Specific Factors," report completed for Oregon Employment Service, (July 1993).

With the passing of the 1992 Job Training Partnership Act (JTPA) amendments, all states are now required to adjust performance standards to obtain improved measures of program effectiveness. This change will represent a significant departure regarding the method used to evaluate Oregon's JTPA programs because the state has continued to use the unadjusted national standards since their inception in Program Year 1988.

The purpose of this paper is to explain to Oregon state employment and training officials, other Oregon state agency officials interested in developing performance measures, and U.S. Department of Labor (DOL) officials the rationale for developing state-based regression models to determine precise adjustments that better reflect client characteristics and local economic conditions across each of the six Service Delivery Areas (SDAs) in Oregon.

The study begins with a brief historical background of JTPA performance standards up to the current 1993 program year. Next, the rationale for using adjusted performance standards is made followed by a "lay-men's" explanation of the use of regression analysis to derive statistically sound adjusted performance measures. Data is presented that shows the economy and JTPA clients in Oregon differ significantly from the national average, which is reason to believe applications of the DOL adjustment models are not the optimal mechanism to account for Oregon's varying JTPA clientele and local economic conditions across the state.

Simulations of Oregon's state-based adjusted performance standards models are presented and compared with simulations of the national DOL model for PY 1991. (This is the most recent period for which follow-up data exists for a complete program year.) This part is the focus of the paper, as it presents three uses of the Oregon state-based adjusted performance standards models, including: (1) improved measures with which to assess the ability of SDAs to meet more realistic performance goals, (2) new measures of relative program performance for use by program managers in assessing

the effectiveness of their programs, and (3) a new index with which to gauge the impact client characteristics and local economy have on total program performance across SDAs.

In addition, a technical discussion for the justification of the Oregon -- as compared with the national DOL -- adjustment models is presented. A strong case is made that the DOL models do not adjust for factors "external" to JTPA programs as accurately as is done in the Oregon state-based models.

The development of the first state-based performance standards models stand as a landmark in public policy evaluation in Oregon. Other state agencies are moving in the direction taken by Oregon JTPA and this paper describes in detail why JTPA will remain in the forefront of new evaluation initiatives. This undertaking directly supports other state initiatives taken to enhance our understanding of the effectiveness of state administrated programs, which are operated to better educate, train, and prepare Oregonians for the skills needed to remain competitive in an ever-changing world.

MORRIS, Clair E., Professor, "Essay I: Ely's Rivalry with James L. Laughlin," *Economists at Wisconsin*, ed. by Robert J. Lampman. Madison: UW Board of Regents, (1993), 52-54.

This is a piece included in a work that was published on the occasion of the centennial celebration of the founding of the Department of Economics at the University of Wisconsin. It details how both Richard T. Ely and J. Laurence Laughlin had been in contention for the Chairmanship of the Department of Economics at the University of Chicago when it opened its doors in the fall of 1892. When Laughlin was chosen, the disappointed Ely accepted a similar position at the University of Wisconsin just 75 miles away. Thus began an intense rivalry between the two departments for students and status within the economics discipline. The next 40 years saw the emergence of two distinct brands of economics known as the "Chicago School" and the "Wisconsin School". Wisconsin became known for its focus on "Institutionalism", whereas Chicago pursued a more mainstream approach to the study of economics. One hundred years later it is the Chicago approach that has survived.

MORRIS, Clair E., Professor, "Some Reflections on Life as a Graduate Student," *Economists at Wisconsin*, ed. by Robert J. Lampman. Madison: UW Board of Regents, (1993), 159-162.

This piece highlights the heady experience of studying economics during the period 1962-1966 when most economists felt that the ability to mold and shape economic destiny was within sight. Disillusionment was to follow in the 1970's, but the era of the "New Economics" that swept Washington in the 1960's was truly exhilarating on campus---definitely a period not to have been missed. This short essay describes what life was like as a graduate student in economics during that time at the University of Wisconsin.

THIERFELDER, Karen E., Assistant Professor (with Sherman Robinson, Department of Agricultural and Resource Economics, University of California, Berkeley, Mary E. Burfisher, U.S. Department of Agriculture, Raul Hinojosa-Ojeda University of California, Los Angeles), "Agricultural Policies and Migration in a U.S.-Mexico Free Trade Area: A Computable General Equilibrium Analysis," *Journal of Policy Modeling*, 15 (October - December 1993), 673-701.

A U.S.-Mexico agreement to form a free trade area (FTA) is analyzed using an 11-sector, three-country, computable general equilibrium (CGE) model that explicitly models farm programs and labor migration. The model incorporates both rural-urban migration within Mexico and international migration between Mexico and the U.S.. In the model, sectoral import demands are specified with a flexible functional form, an empirical improvement over earlier specifications which use a constant elasticity of substitution (CES) function. Using the model, trade-offs are identified among bilateral trade growth, labor migration, and agricultural program expenditures under alternative FTA scenarios. Trade liberalization in agriculture greatly increases rural-urban migration within Mexico and migration from Mexico to the U.S.. Migration is reduced if Mexico grows relative to the U.S. and also if Mexico retains farm support programs. However, the more support that is provided to the Mexican agricultural sector, the smaller is bilateral trade growth. The results indicate a policy tradeoff between rapidly achieving gains from trade liberalization and providing a transition period long enough to assimilate displaced labor in Mexico without undue strain.

Presentations

FREDLAND, J. Eric, Professor and LITTLE, Roger D., Professor, "Defense Contractor Profitability and Tobin's q," InterUniversity Seminar on Armed Forces and Society, Baltimore, Maryland, 22-23 October, 1993.

GIBB, Arthur, Associate Professor, "Back to Basics: Course Design at the Introductory Level," Eastern Economic Association, Boston, Massachesetts, March 19, 1994.

KULCHYCKY, Ksenia M., Assistant Professor, "Taxes, Tariffs and the Distribution of Real Assets of U.S. Multinationals," Western International Economic Association, Vancouver, Canada, June 1994.

KULCHYCKY, Ksenia M., Assistant Professor, "Pacific Basin Direct Investment in the U.S.," Western International Economic Association Pacific Rim Conference, Hong Kong, January 1994.

LITTLE, Roger D., Professor "Senate Military Veterans Voting on Defense Issues, 1983-90," Inter-University Seminar on Armed Forces and Society, Baltimore, Maryland, 22-23 Oct, 1993.

THIERFELDER, Karen E., Assistant Professor, "Trade and Employment in General Equilibrium," Western Economic Association Meetings, Lake Tahoe, Nevada, 19 -23 June 1993.

THIERFELDER, Karen E., Assistant Professor, "Policy Noise around the North American Free Trade Agreement: The Effects on Concurrent NAFTA, GATT, and U.S. Farm Policy Reform," American Agricultural Economic Association Meetings, Orlando, Florida, 2-4 August 1993.

THIERFELDER, Karen E., Assistant Professor, Agricultural Policy Reform, and Labor Mobility," International Agricultural Trade Research Consortium, San Diego, California, 12 -14 December 1993.

THIERFELDER, Karen E., Assistant Professor, "Prices, Wages, and Migration in a U.S. Mexico Free Trade Area," American Economic Association Meetings, Boston Massachusetts, 3 January 1994.

THIERFELDER, Karen E., Assistant Professor, "Labor Market Policies and the Distribution of Income in Bangladesh," Western Economic Association Meetings, Vancouver, British Columbia, 29 June - 3 July 1994.

English

Professor Michael P. Parker
Chair

The highlight of the research year for the Department of English came in April with the announcement that Associate Professor Bruce E. Fleming had won the Academy's Research Excellence Award for 1993-94. A scholar who combines unusual breadth of interests with analytical depth, Professor Fleming has published extensively on modern dance and film as well as on literature; he is also increasingly acclaimed as a creative writer, winning notice for his short stories and personal essays. The capstone of his achievement this year was the publication of *Caging the Lion: Cross-Cultural Fictions*, a sweeping consideration of the ways in which Westerners perceive non-Western cultures through novels, film, and dance. Professor Fleming's pioneering work on the relations between the arts and on the literatures of the Third World has already borne fruit in the English curriculum through special courses on the colonial experience and Islamic literature as well as in interdisciplinary honors seminars.

Other members of the department have been similarly productive during the 1993-94 academic year. Members of the English faculty published two other books--*Past Crimson, Past Woe: The Shakespeare-Beckett Connection*, edited by Assistant Professor Anne Marie Drew, and the second edition of *The Creative Writer's Handbook* by Professor Allan B. Lefcowitz and Professor Philip K. Jason--and placed over 25 articles on topics ranging from retainer loyalty in Anglo-Saxon warfare to the mutilation of dolls to the precise amount that Samuel Johnson was paid for writing *Rasselas*. Members of the English Department also delivered over 20 papers at scholarly meetings, including the annual conventions of the most prestigious professional organizations. In addition, several faculty members won significant outside research grants: Assistant Professor Allyson Booth was awarded a Northeast Modern Language Association Summer Fellowship, Assistant Professor Nancy A. Mace a National Endowment for the Humanities Summer Stipend, Assistant Professor Elizabeth McHenry a Ford Foundation Postgraduate Fellowship, and Professor Molly B. Tinsley a National Endowment for the Arts Grant. These awards attest to the increasingly sophisticated level of scholarly activity within the department and to the national reputation that the Naval Academy has won as a center for humanistic learning.

Midshipman research was represented this year by Midshipman First Class Craig S. Newton's exploration of novelistic form, "In the Shadow of a Mountain," and directed by Professor Molly B. Tinsley and Midshipman First Class Michael S. Mattis's much acclaimed Trident Project, "The 'Great Code' in Shakespeare's Henriad," directed by Professor David A. White. In his study, Midshipman Mattis applied the critical theories of Northrop Frye and Walker Percy to the four plays that compose Shakespeare's first Henriad, arguing for the central significance of the Biblical background to the playwright's ethical scheme. Midshipman Mattis will continue to explore Shakespeare next year as a student at Oxford University, which he will be attending as a Fitzgerald Scholar.

The paradigm that this work reflects--self-generated efforts supported by institutional funding that culminate in published work or conference papers--keeps the department vital and effective in its support of the Naval Academy mission. In the end, all of our research and publications focus ultimately on one objective: the very best education for midshipmen.

Sponsored Research

Postcards from the Trenches: Negotiating the Space Between Modernism and the First World War

Researcher: Assistant Professor Allyson Booth
Sponsor: Naval Academy Research Council (OMN)

The researcher has completed a book manuscript about the relationship between modernism and World War I that has received a positive reader's report from Oxford University Press. Though many of the works now identified as distinctively modernist were produced during war years, few of them are the projects of soldiers. Thus, the gap between soldier and civilian--one of the most complicated features of the relationship between literary modernism and cultural history--structures the writer's attempt to understand both how modernists responded to World War I and ways in which they protected themselves from its grisly details. Throughout the work, the researcher traces ways in which literary and architectural modernism participated in a culture shaped and traumatized by war.

The Cultural World in *Beowulf*

Researcher: Professor John M. Hill
Sponsor: Naval Academy Research Council (OMN)

This project, now complete, is being copy-edited for publication at the University of Toronto Press. The book is an anthropologically inspired interpretation of social institutions and features in the Old English poem *Beowulf*. In five chapters it covers such topics as feuds and settlements, the social and political uses of genealogies, the nature of jural action and divine or mythological sanctions, gift-giving and the economy of honor, and the psychodynamics that underlie the conceptions of personhood, heroic action, and evil.

The British Music Trade in the Late Eighteenth Century

Researcher: Assistant Professor Nancy A. Mace
Sponsors: National Endowment for the Humanities and the
Naval Academy Research Council (OMN)

Although music publishing is important in the history of eighteenth-century theater, music, literature, and the print trade, scholars have virtually ignored this area. Beginning with a collection of thirty lawsuits in the Public Record Office, London, which have been hitherto unknown to scholars, the researcher is studying the music trade in the late eighteenth century--the relationship between book and music sellers, their conflicts over copyright, and their business practices.

This research project began two summers ago. A database of music sellers and others named in the suits has been developed, and many materials have been transcribed. The study will eventually lead to a book.

The "Great Code" in Shakespeare's Henriad

Researcher: Midshipman 1/C Michael S. Mattis
Adviser: Professor David A. White
Sponsor: Trident Scholar Program

Northrop Frye has proven to be one of the most important literary theorists of contemporary literary criticism. His literary theories, as presented in *Anatomy of Criticism* and *The Great Code,* argue that "Biblical literary

narrative . . . had set up an imaginative framework--a mythological universe--within which Western literature had operated down to the eighteenth century and is to a large extent still operating." Frye shows how Biblical narrative has become, unconsciously, the context for Western understanding of symbols and imagery in art and literature. This project tests Frye's theories about the influence of Biblical imagery and narrative on a masterpiece of Western Art, Shakespeare's Henriad (*Richard II, Henry IV Part I, Henry IV Part II,* and *Henry V*). Although many literary critics have examined Shakespeare's use of the Bible, "most of them catalogue the Biblical allusions without discussing their functions in the plays." The research focuses on Shakespeare's use of the Bible in his drama; however the investigation will be how his Henriad was touched by "the great code" of Biblical narrative revelation. Specifically, the researcher examines how Shakespeare has manifest the seven phases of revelation into the Henriad, his longest coherent dramatic effort.

Chaucerian Satire

Researcher: Professor Timothy D. O'Brien
Sponsor: Naval Academy Research Council (OMN)

The aim of this project is to develop a theoretical and historical groundwork for reading Chaucer's *Canterbury Tales* as a satire. Though much commentary on Chaucer praises the satiric elements in his works, only two books take a rigorous, generic approach to his satire; and they cover very little of the *Canterbury Tales*. This project will focus on works describing Chaucer's society, on studies in the genre of satire and in genre theory, and on other satiric works of Chaucer's age.

Rocking the Cradle of the Navy: The Naval Academy Career of William Oliver Stevens

Researcher: Professor Michael P. Parker
Sponsor: Naval Academy Research Council (OMN)

Anyone with even the slightest interest in naval history knows of Alfred Thayer Mahan and the tremendous influence he exerted upon the modernization of the U.S. Navy at the turn of the century. Largely forgotten, however, are the men who transmitted the ideas of Mahan to naval officers and who revolutionized the teaching of naval history--the civilian professors of the Naval Academy's old English Department. Preeminent among this new generation of naval historians was William Oliver Stevens (1878-1955). The author of 47 books, he emerged during the twentieth century as the most authoritative and most imaginative of the many civilian writers on naval affairs. His *History of Sea Power* (1920), co-authored by Allan Westcott, was the first textbook to survey the influence of seapower from the ancient world to modern times; it remained a required text at the Academy for thirty-five years. Steven's brilliant career at the Academy came to an abrupt end in 1924 when the superintendent, Rear Admiral Henry Wilson, refused to renew his contract. Officially, Stevens was let go for reasons of economy; the full story, in fact, is a complex fabric that weaves together naval politics, academic freedom, family feuds, and the recurrent controversy over the place of the civilian faculty at the Academy. An article on the subject has been accepted by *Naval History* for publication.

A Critical Study of Mary Gordon's Fiction

Researcher: Associate Professor Eileen Tess Tyler
Sponsor: Naval Academy Research Council (OMN)

This is a book-length study of the thought and work of Mary Gordon, a highly acclaimed contemporary American writer. This book traces Gordon's development as a novelist and short story writer from several perspectives: the aesthetic, religious, social, and political ideas articulated in her many essays, reviews, and interviews; the Irish immigrant tradition in America; the tradition of fiction by and about women; the perspective

of ideas about houses, domestic spaces, and shelter--a crucial symbolic complex pervasive throughout Gordon's writing. This project is fully underway. A partial draft of this manuscript is already available.

Independent Research

William Vollmann

Researcher: Professor Neil Berman

Work is just beginning on this new project. Since Vollmann's output is large despite his youth, and his novels long, allusive, and difficult, it is much too early to be specific about the focus of this project. Initial reading has begun with significant progress anticipated throughout the summer.

Lady Di and Elizabeth Tudor: Who Owns the Face?

Researcher: Associate Professor Anne Marie Drew

This essay will be published in a collection entitled *Women and the Media*. The essay examines the ways in which Lady Di and Queen Elizabeth the First controlled their public images through manipulation of the media.

Giving Up on The Answers: Shaw's Lack of Misogyny

Researcher: Assistant Professor Anne Marie Drew

This essay will appear in *Staging the Rage: The Web of Misogyny in Modern Drama*. The essay examines the ways in which Shaw's potential misogyny changes shape as his career progresses. In his early plays, like *Arms and the Man*, he is tempted to supply answers to the "woman question". In his later plays like *Too True to be Good*, he does not provide answers. Instead, he portrays women who are content to formulate their own questions and seek their own solutions.

Feminine Shadows: Lear's Fool in the Nineteenth Century

Researcher: Associate Professor Anne Marie Drew

This project is an ongoing attempt to discuss the use of women to portray Lear's Fool in Shakespeare's *King Lear*. The use of the female fool was common from 1838 until the turn of the century. This essay, which is currently under revision for *Nineteenth Century Theatre*, discusses the implications of using a female fool.

Empty Nest, Full Life: After Your Children Leave Home

Researcher: Associate Professor Anne Marie Drew

This book will be published by Abingdon Press in March 1995. Based on interviews and personal experience, the book is a look at the opportunities of an empty nest.

Women in the Antebellum South

Researcher: Associate Professor Mary D. Howland

The researcher is in the preliminary stages of investigation into living conditions on southern plantations in the antebellum South. Research is being performed primarily at the College of William and Mary's Swan Library with particular interest directed toward the accuracy of William Faulkner's portrayal of Southern women in *As I Lay Dying, The Sound and the Fury, Absalom, Absalom* and *Go Down Moses*. Collections of letters are proving especially helpful.

Vietnam War Themes in Korean War Literature

Researcher: Professor Philip K. Jason

Critics of Vietnam War literature have codified a list of that war's distinguishing features as represented in imaginative literature. These features include the confusion of friend and enemy, the destruction of those the U.S. meant to help, a belief in the decisiveness of superior technology, the enemy's ability to dominate at night, the frustration of limited objectives, and the progress criterion of body count. However, an examination of the largely forgotten literature of the largely forgotten Korean War reveals that most of these supposedly unique features of the Vietnam experience exist in the imaginative responses of those who wrote about the Korean Conflict. The investigator has detailed these and related findings in an article being submitted for publication.

Transcendental Loyalty in *The Battle of Maldon*

Researcher: Professor John M. Hill

The poet of *The Battle of Maldon* dramatizes a new retainer ideal on the battlefield--an idea of loyalty to the dead leader that transcends all living ties of kinship or lordship, including one's obligation to oneself. This is done by group urging, however, and thus forms a model of group values idealized under suicidal conditions.

EDIT-IT

Researcher: Professor Allan B. Lefcowitz

This is an ongoing project to develop a computer program with text to assist students in learning how to edit as a prelude to improving their own writing.

Henry Fielding's Novels and the Classical Tradition

Researcher: Assistant Professor Nancy A. Mace

Although scholars have noted that Henry Fielding often uses classical allusions and quotations in his novels, they have underestimated the importance of the classics to our understanding of his audience, sources, characterization, and rhetorical techniques. By studying his classical references within the context of what readers in the eighteenth century knew about ancient literature, we gain new insights into Fielding, his readers and the genealogy of his fiction.

The manuscript of this project is complete; it is currently being reviewed by a major university press.

Homer Nods and Fielding Winks:
A Few Narrative Problems in *Jonathan Wild*

Researcher: Assistant Professor Nancy A. Mace

Many critics have considered Henry Fielding's *Jonathan Wild* a problematic work because of its supposed heavy-handed irony and the unevenness of the characters and the narrative structure. This project will demonstrate that the "problems" of the narrative are, in fact, clues that we cannot identify Henry Fielding with the narrator of the novel. In *Jonathan Wild*, Fielding has created a narrative persona through whom he can satirize his own contemporaries who write without sufficient learning or moral judgment.

This article has been completed and will soon be submitted to a journal for publication.

Forgotten Readers: African American
Literary Societies, 1830-1940

Researcher: Assistant Professor Elizabeth McHenry

The researcher aims to uncover literary societies of African American readers and writers in the United States before the Harlem Renaissance. The goal is to publish material in a book which will provide a better understanding of African American literary history.

Character Development and the Teaching of English

Researcher: Professor Charles J. Nolan, Jr.

The researcher has begun reading on issues of character development as a result of his participation as a member of Quality Management Board 6 (Character Development). Just where this research will go and just what its relationship to other scholarly projects will be are matters of some uncertainty at this point. No doubt, there will be connections between the researcher's teaching and the issues he is exploring in the literature of character development.

The Wisdom of Cliches

Researcher: Professor Charles J. Nolan, Jr.

Having recently finished fours years as a department chair, the writer explores the surprising wisdom found in cliches as they pertain to academic administration. The article is about three-fourths completed.

An Edition of the Poems of Edmund Waller

Researcher: Professor Michael P. Parker

Although one of the most accomplished and influential poets of the seventeenth-century, Edmund Waller has remained largely neglected by modern critics. This neglect is due primarily to the lack of a reliable standard edition of his works. The most recent edition, that of George Thorne Drury, was published one hundred years ago, in 1892, and it fails to meet the exacting standards of editorial practice established by W.W. Greg, Fredson Bowers, and Thomas Tanner in the twentieth century. Several scholars have begun new editions of Waller over the past seventy-five years, but none has been brought to completion. Most recently, Philip R. Wikelund of Indiana University labored over an edition from 1954 until his death in 1989. Professor Wikelund's literary executor, Professor Earl Miner of Princeton University, asked the researcher to take over Wikelund's work, and

he has agreed to do so as co-editor with Prof. Timothy Raylor of Carleton College. The first goal is to produce a census of Waller editions and manuscripts as well as a complete bibliography of secondary works on Waller. The second goal is to reexamine Wikelund's theory of the Waller copy-text: his choice of the 1664 edition may not conform to modern editorial practice. This project is large in scale and will take a number of years to complete, but the result will be a major contribution to modern scholarship.

A History of Presidents' Hill in Annapolis

Researcher: Professor Michael P. Parker

The area of Annapolis now known as Presidents' Hill lies between West Street, Taylor Avenue, and the Old Baltimore, Washington, and Annapolis Railroad right-of-way. It consists of four streets: Munroe Court, Madison Place, Hill Street, and Jefferson Place. The neighborhood was first developed by the Brewer family in the early 1890s as a fashionable suburb of Annapolis; the crash of 1893, however, sent real estate prices plummeting, and the remainder of the lots were developed on a less pretentious scale. In the early 1900s Presidents' Hill was the home of many small businessmen and craftsmen, including some who went on to become significant forces in the Annapolis commercial community. Two mayors of Annapolis lived in Presidents' Hill; another, current mayor of Annapolis Alfred A. Hopkins, has close family links to the community. The neighborhood began to change dramatically in the 1960s as the traditional family and social networks that held it together were eroded; the availability of Title 8 low-income housing funds led to a marked increase in rental property in the neighborhood. In 1984, Presidents' Hill was included in the Annapolis Federal Register Historic District, and it has increasingly become subject to gentrification over the last decade. This history will trace the chronicle of Presidents' Hill from its founding up to the present day, relying on interviews with long-time residents, newspaper accounts, and property records. A building-by-building survey of the community's architectural and historic landmarks will complement the narrative.

Missing Normal

Researcher: Professor Molly B. Tinsley

This narrative--a novel in progress--follows events in the lives of three female characters: one 39, one 25, and one 13. None lives in a "normal" family: their paths intersect and then merge.

King Travel Diary

Researcher: Professor David Tomlinson

Olive King kept a detailed travel diary of the trip she and her husband took for a year (1921-22). They traveled by car from Missouri to California and back before returning to the District of Columbia. The roads, the national parks, the winter at Laguna Beach all come in for comment in the literate diary which is being edited for publication.

The Legacy of Tennyson's *In Memoriam A.H.H.*, 1853-1900

Researcher: Associate Professor Eileen Tess Tyler

This is a long-term project. Its purpose is to determine the nature and extent of *In Memoriam's* influence upon English poetry between the time of its publication (1850) and the end of the Victorian period. Many of the works under investigation are neglected masterpieces. Others are of interest principally to literary historians and reception theorists and critics. This investigation involves categorization, contextualization, comparative and critical analysis, and study of the reception of the works of some twenty poets influenced by Tennyson's masterpiece.

Discernment in Victorian Literature

Researcher: Associate Professor Eileen Tess Tyler

This study examines the presentation of moral and vocational decision in Victorian literature and relates these literary renderings to their roots in the literature of Christian discernment. Tennyson's *Idylls of the King* and the fiction of Charles Dickens and Charlotte Bronte are deeply rooted in this tradition. Special attention is being given to the psychological dimension of discernment-- especially in the depiction of desolation and consolation-- and to the angelic and demonic iconography associated with discernment.

Songs in the Night and *Ceremonies of the Horseman*

Researcher: Professor John Wooten

Songs in the Night is a first novel. It has been in the works for two years. At present, the writer is in the midst of a sequel, tentatively titled *Ceremonies of the Horseman.* An agent has undertaken to represent *Songs.* It has been making the rounds of selected publishers. Even though it has not yet been accepted for publication, there has been encouraging response to it. The author has received good criticism and, as a result, has been in the process of making some changes. The second novel, *Ceremonies,* is half-complete at this point. Work on it will be complete in the summer of 1994.

Research Course Projects

In the Shadow of a Mountain

Researcher: Midshipman 1/C Craig S. Newton, USN
Adviser: Professor Molly B. Tinsley

The aim of this project was to provide valuable experience in writing historical fiction. The student sought to integrate elements of contemporary fiction, such as use of the first person and shifting narrative voice, with the traditional mechanisms of the genre. Through extensive historical research, the student managed to balance fact with creative license to create six narrative voices, all elaborated to different degrees within the project. The final manuscript represents several iterations in the creative process. The first two chapters represent a substantial amount of editing, revising, and expanding but are not yet nearly complete. The four subsequent chapters indicate stages in the writing process leading to the level of the early chapters. While the manuscript, therefore, does not represent a completed work, the majority of the project's value comes from the processive aspect of writing, particularly writing in a genre heavily reliant upon fact. The student learned that a novel, while a daunting task requiring almost complete academic attention, is by no means an unapproachable literary form for a young author.

Publications

CLARIDGE, Laura, Associate Professor, Book Review of Barbara Gelpi's *Shelley's Goddess: Maternal, Language, Subjectivity, Keats-Shelley Review* (1993).

Shelly's Goddess attempts a marriage of the old and the new: on the one hand, it recycles conundra about the importance of childrearing to a poet's achievements, while on the other, it pressures such mainstream feminist positions with post-structuralist linguistic theory. Along the way, Gelpi provides a mini cultural history of familial interactions during the period of British Romanticism.

COUSINEAU, Diane, Assistant Professor, "Women and Autobiography: Is There Life Beyond the Looking Glass?" *Caliban,* 31 (1994), 97-105.

An exploration of the implications of Lacan's theory of the mirror stage of women's autobiography, this essay focuses on Virginia Woolf's "Sketch of the Past," Vivian Gornick's *Fierce Attachments,* and Jamaica Kincaid's *Annie John.* Each testifies to the captivating hold of the mother's image on the daughter and her effort to create an innovative form of life writing that challenges the confines of this specular relation. The article also situates these works in relation to issues raised by theorists of autobiography today, such as the boundaries between fiction and fact, imagining and remembering and the present and the past. More generally, it attempts to register the tension between the image and the word, crucial to both literary texts and psychoanalytical thought.

DREW, Anne Marie, Associate Professor, *Past Crimson, Past Woe: The Shakespeare-Beckett Connection.* New York: Garland, (1993).

The first collection of essays to address the connections between William Shakespeare and Samuel Beckett. This volume contains essays by scholars and actors. In addition to editing the volume and writing the introduction, Asst. Prof. Drew contributed an essay, "No Deposit, No Return: The Cap and Bells in HAMLET and ENDGAME".

DREW, Anne Marie, Associate Professor, Review of *The Friendly Shakespeare* by Norrie Epstein. *Baltimore Sun.* January 10, (1993): 6c.

It is a book review of recent Shakespearean criticism.

FLEMING, Bruce E., Associate Professor, *Caging the Lion: Cross-Cultural Fictions.* New York: Peter Lang, (1993).

This work is a sweeping consideration of the ways in which Westerners perceive non-Western cultures, a perception shown in novels, films, and dance works. Among the literary works considered are novels by Ernest Hemingway, Samuel Butler, Charlotte Bronte, and Chinua Achebe. Films include the recent Hollywood movies "Dances With Wolves" and "Out of Africa." Cultural perceptions considered include the differing way the AIDS virus is understood in Africa and the West, and the place and function of scholarly discourse. The book argues against any simplistic view of the "Other" outside our borders, whether this comes from the intellectual right or the left. It suggests that all perceptions of the non-Western world are ultimately from the point of view of the Western perceivers, and insists that clarity on the subject of the world outside must start with this realization.

FLEMING, Bruce E., Associate Professor, "*The Waste Land* and Film Theory," *SB Academic Review,* Kerala, India, (July-December 1993), 45-58.

T.S. Eliot's epic poem *The Waste Land* is one of the most celebrated Modernist masterpieces in English. Understanding of it, however, has varied since its publication. In recent years, a return to the earliest perception of it as essentially fragmentary has been led by the eminent scholar A. Walton Litz, who proposed consideration of the poem in terms of early twentieth-century (Russian) film theory. This article develops such a consideration in terms of Russian film theory, specifically the theories of both Sergei Eisenstein and Lev Kuleshov, the two most important Soviet film theorists. The advantage of considering Eliot's written work in terms of theories of images is that this allows us to foreground his techniques of collage and juxtaposition, aspects which have tended to be neglected in the 60s, 70s, and 80s in the critical attempt to see the poem as a unified work whose fragments were organized as part of a larger whole.

FLEMING, Bruce E., Associate Professor, "Passivity and the Unhappy (Wo) Man: Dreiser's *Sister Carrie,*" *Indian Review of American Studies,* ASRC Hyderabad, India, (Summer 1991), 39-45.

Theodore Dreiser's classic novel *Sister Carrie* is usually considered as part of the movement of American "naturalism," a movement whose other practitioners include Stephen Crane and Frank Norris. The article suggests, without fundamentally challenging this ascription, that Dreiser's first work can also be considered profitably in the tradition of European phenomenology and late nineteenth-century philosophy that is sometimes seen at odds with the objectivist philosophy underpinning naturalism. Drawing on Wittgenstein's use of Schopenhauer, the article argues that one of Dreiser's strong points in *Sister Carrie* is his fusion of the subjective inner worlds of his characters with the outside world, whereby the outside world becomes an extension of the inside. This, it argues, is more typical of the notion of an internal "duration" developed by thinkers such as Henri Bergson than of positivist philosophers such as Herbert Spencer, with whom naturalism is more usually associated.

FLEMING, Bruce E., Associate Professor, "Balanchine's 'Serenade' as a Modernist Work," *Studies in Dance History*, 3 (Fall 1993), 45-52.

This article situates "Serenade," a seminal work of the twentieth century's greatest choreographic master, George Balanchine, in the context of Modernist literature and painting in which it naturally belongs. This sort of consideration of dance in connection with the other arts represents something of a new departure in dance history, which has traditionally been quite insular with respect to the other art forms. The article argues that "Serenade" finds its natural cousins not so much in other dance works, but instead in Modernist written works such as those of Gertrude Stein, Virginia Woolf, and T.S. Eliot, and in paintings by artists such as Braque and Picasso. An analysis of the fragmentary role played in "Serenade" by plot and of the relationship between the individual and group makes the parallels clear, using as its principal example one sequence from the dance's initial movement.

FLEMING, Bruce E., Associate Professor, "Pictures of Pictures: Reference and Reality in Two Script Versions of *Potemkin,*" *Intertextuality in Literature and Film*, ed. Elaine D. Cancalon and Antoine Spacagna (Gainesville: UP of Florida, 1993), 127-140.

One of the most highly-discussed topics in contemporary critical consideration of novels and films is that of "intertextuality," by which is meant not just the relation between one work (or "text") and another, but also an exploration of the fact that in some fundamental way all texts refer to and are generated by other texts. This article considers a form of writing usually neglected by scholars, the printed film script. It argues that printed scripts stand in a peculiar relation to the films of which they are scripts. This relation creates what the article calls a heightened "reality effect," based on the reference to a film that is implicit in the fact of the script itself. The examples used are two versions of scripts for the most famous film of the great Soviet director Sergei Eisenstein, *Battleship Potemkin*.

FLEMING, Bruce E., Associate Professor, "A Conversation in Conakry," *Dance View* 11 (Autumn 1993), 59-61.

This essay considers the way non-Western dance is perceived by Western critics, using as its example the well-known dance troupe from Africa's Republic of Guinea, "Les Ballets Africains." A report on a conversation between the author and the directors of the ballet troupe in 1992, the essay considers the reaction of all parties to English critiques of the troupe's appearances in London. Western critics tend to look for a quality that is without meaning for the Africans, what Westerns usually call "authenticity," or fidelity to village dance styles. Contemporary African troupes, by contrast, are frequently interested in creating a fusion of styles that is not something which can be placed in the context of what was actually done in the villages. The essay considers the various points of view of the Westerners and non-Westerners regarding the desirability of the "authenticity," and concludes that the Western need to find this quality in artworks from the Third World expresses our Westernness sooner than any objective set of qualities of the world outside our borders.

FLEMING, Bruce E., Associate Professor, "In Utter Darkness," *Dance View* 11 (Winter 1993-94) 56-60.

The presupposition of dance criticism is that of the objectivity of the critic, at least to the extent of being able to separate givens of the subjective perception situation from what is happening on the stage. This essay calls into question this assumption, using as its example three performances of a work by the choreographer Molissa Fenley entitled "State of Darkness." Its conclusion is radically subjectivist, suggesting finally that there is no way to separate the givens of an individual perceiver's reaction from the fact that it is his or her own reaction. This is held to be a peculiar quality of dance, an art form that lacks a "text." This separates dance as an art from literature, painting, and music, all of which take as their point of departure objectively extant works of art.

GILLILAND, C. Herbert, Jr., Associate Professor, "Raphael," *Research Guide to European Historical Biography 1450-Present* 7 (Washington, D.C.: Beacham Publishing, 1993) 4305-4313.

This reference article summarizes the life of the Italian Renaissance master, evaluates major biographies and primary biographical sources, locates his major extant works, and identifies important pertinent museums, landmarks and ancillary reference sources.

GILLILAND, C. Herbert, Jr., Associate Professor, "Benvenuto Cellini," *Research Guide to European Historical Biography 1450-Present* 5 (Washington, D.C.: Beacham Publishing, 1993), 2596-2603.

This article summarizes the life of the sixteenth-century Italian artist and autobiographer, evaluates major biographies and primary biographical sources, locates his major extant works, and identifies important pertinent museums, landmarks and ancillary reference sources.

JASON, Philip K., Professor, "How Dare She? Susan Fromberg Schaeffer's *Buffalo Afternoon* and the Issue of Authenticity," *Critique: Studies in Contemporary Fiction*, 34.3 (Spring 1993), 183-192.

One of the more heated issues in the study of Vietnam War literature has to do with the relationship between the writer and the subject. Many Vietnam War veterans, and a good number of critics and reviewers, discount imaginative works that presume to treat the war written by individuals who were neither participants nor witnesses arguing that these writings are bound to be unauthentic. However, an examination of several meanings of "authenticity" reveals ways in which the autobiographical basis and bias are irrelevant. Key among these is a philosophical meaning derived from the writings of Jean-Paul Sartre that equates authenticity with the capability of transforming the reader. Schaeffer's novel stands as the primary case in point.

LEFCOWITZ, Allan B., Professor (with Professor Philip K. JASON), *The Creative Writer's Handbook* Englewood Cliffs, New Jersey: Prentice-Hall, (1994).

This is the second, thoroughly revised edition of the first creative writing text developed for undergraduate students. It features sections on taking a professional stance, journal keeping, point of view, research, diction, and the major genres, as well as sections on presenting manuscripts, using the computer, references, and a glossary. The text includes over 250 exercises, examples from student texts as well as from professional writers, and practical suggestions about writing practices to avoid.

LEFTWICH III, William G., Major, USMC, "Lieutenant Colonel Bill Leftwich: Remembering the Man Behind the Trophy," *Shipmate*, (November 1993), 17-18.

This article reflects an examination of the writer's father's leadership qualities. It was developed from interviews with a number of the Colonel's Marine seniors, peers, and subordinates to determine what traits made him so esteemed in their eyes. Utilizing the Marine Corps' criteria for the awarding of the Leftwich Trophy for Outstanding Leadership, the writer shows how his father epitomized those attributes. He was competent, confident, and genuinely cared for the welfare of his subordinates. Finally, he was always true to himself. Ultimately, Lieutenant Colonel Leftwich was an outstanding leader because he worked hard at being one.

MACE, Nancy A., Assistant Professor, "What Was Johnson Paid for *Rasselas*?" *Modern Philology* (May 1994), 455-458.

In the standard edition of Samuel Johnson's *Rasselas* published in 1990, Gwin Kolb states the common opinion that Johnson was paid 100 pounds for the first edition of this work and 25 pounds for the second edition. A lawsuit discovered in the Public Record Office, London, reveals that this assumption is false. The bill of complaint in this suit records verbatim Johnson's assignment of the copyright to William Strahan, the Dodsleys, and William Johnston. It reveals that Johnson was paid only 75 pounds for the first edition of this work.

MACE, Nancy A., Assistant Professor, "The History of the Grammar Patent, 1547-1620." *Papers of the Bibliographical Society of America* Vol. 87 (June, 1994), 419-436.

Because it involves some of the most important members of the Stationers' Company and is one of the few royal patents granted continuously from the sixteenth through the nineteenth centuries, the grammar patent can add substantially to our knowledge of the developments leading up to the first copyright law in 1610 and to our understanding of the dynamics of the seventeenth- and eighteenth-century book trade. This project traces the history of the patent from 1547-1620; this period in its history is not clearly understood by scholars. Research has revealed that the patent was considered one of the most valuable granted to printers; it has also uncovered the identities of several individuals who were not known to be involved with the grammar.

MADISON, Robert D., Associate Professor, ed, Frederic Denison's *Sabres and Spurs: The First Regiment Rhode Island Cavalry in the Civil War*, Baltimore, Maryland: Butternut and Blue, (1994).

Frederic Denison, the author of *Sabres and Spurs*, was a Baptist preacher of the "church militant." Born September 28, 1819, in Mystic, Connecticut, his motto

might well have been that of this book: "They all hold swords, being expert in War." From 1838 to 1859, he tells us in *A Chaplain's Experience*, he served at intervals in the state militia of Connecticut, "rising from the rank of a private in infantry to the post of brigade chaplain" in the state. He served for eight years as the pastor of the Baptist Church in Westerly, Rhode Island, and the outbreak of the Civil War found him pastor of a church in Central Falls and chaplain of the Pawtucket Light Guard. His book was published by The First Rhode Island Cavalry Veteran Association in 1876.

MCHENRY, Elizabeth, Assistant Professor, "The Telling 'I': Teaching Writing Through Stories and Storytelling," *Notes in the Margins*, (June 1993), 4-6.

"The Telling 'I': Teaching Writing Through Stories and Storytelling" explores how the stories students tell of their own lives and the lives of their families and friends might be used to teach writing in the university classroom. In addition to providing a text which teaches the mechanics of writing, this written storytelling is also effective in framing communities and forming individual identities.

PARKER, Michael P., Professor. "Thomas Carew" in *Dictionary of Literary Biography*, 126 42-54.

Thomas Carew (1594-1640) was the poetic *arbiter elegantiarum* of court of Charles I. He gave a last witty spin to the Petrarchan lyric, composed the most notorious erotic poem of the seventeenth century, and penned the

most frequently quoted and possibly the most astute critical assessments of the two greatest literary figures of the age, John Donne and Ben Jonson. Carew was ultimately one of the great transitional figures of English poetry. Although deeply grounded in the traditions of the Renaissance, he pioneered the lighter, more elegant style that has come to be known as cavalier verse and in many respects anticipated the literary trends that would only emerge in full form at the Restoration. This article examines Carew's life and poetic *oeuvre*, surveys his current critical reputation, and suggests the reasons for growing interest in his work over the past twenty years.

TINSLEY, Molly B., Professor, "Affairs of Strangers," *Prairie Schooner*, 107-124.

A widow enrolls in a figure drawing class and encounters two characters--a young rebellious girl and an old musician--who cause her to reexamine her life.

WHITE, David A., Professor, "Review of Marcel LeFebvre's *Spiritual Journey*," *The Angelus* (April 1994) 14-15.

This review discusses the last published volume of controversial Archbishop Marcel LeFebvre. The work focuses on the writings of St. Thomas Aquinas and provides a vision of the manner which "Thomism" must remain the bedrock of the Catholic faith. The book offers a clear challenge to post-Vatican II approaches to apologetics.

Presentations

BOOTH, Allyson, Assistant Professor, "Swimming from New York to London: The Fisher Kings of Terry Gilliam and T.S. Eliot," Eighteenth Annual Colloquium on Modern Literature and Film: Literature and the Other Arts, Morgantown, West Virginia, 10 September 1993.

BOOTH, Allyson, Assistant Professor, "The Architecture of Loss: Teaching *Jacob's Room* as a War Novel," Virginia Woolf Conference, Annandale-on-Hudson, New York, 10 June 1994.

BROWNE, Marlene, Associate Professor, "Sibling Relationships in Toni Morrison's Fiction," Northeast Modern Language Association Annual Convention, Pittsburgh, Pennsylvania, 9 April 1994.

CLARIDGE, Laura, Associate Professor, "Literary Consciousness," South Atlantic Modern Language

Association, Atlanta, Georgia, 12 November 1993.

CLARIDGE, Laura, Associate Professor, "The Object of Beauty in Byron and Shelley," Modern Language Association, Toronto, Canada, 30 December 1993.

DREW, Anne-Marie, Associate Professor, "Acting Workshop," Greensboro Elementary School, Greensboro, Maryland, February 1994.

DREW, Anne-Marie, Associate Professor, "Writing Stories," Greensboro Elementary School, Greensboro, Maryland, February 1994.

FETROW, Fred M., Professor, "Jilted by Jesus: Religious Faith Lost and Found in American Literature," Annapolis Area Unitarian Church, Annapolis, Maryland, 18 July 1993.

FETROW, Fred M., Professor, Chair, "Sibling Relationships in African American Literature: Support and Rivalry Among Brothers and Sisters," Northeast Modern Language Association Annual Convention, Pittsburgh, Pennsylvania, 9 April 1994.

FETROW, Fred M., Professor, Secretary, "The Black Male: A Revisionist View," Northeast Modern Language Association Convention, Pittsburgh, Pennsylvania, 9 April 1994.

FLEMING, Bruce E., Associate Professor, "Text and Ballet: Romeo and Juliet," "Crossed Stars: Ballet Versions of Romeo and Juliet," Conference of the San Francisco Performing Arts Library and Museum, San Francisco, California, 31 April-1 May 1994.

FLEMING, Bruce E., Associate Professor, "Teaching Wilfred Owen: WWI War Poets," Conference of the International Association for Narrativity, Vancouver, B.C., 1-3 May 1994.

GILLILAND, C. Herbert, Jr., Associate Professor, "Body and Soul in Andrew Marvell's 'To His Coy Mistress,'" Fifth International Conference on the Seventeenth Century, Durham, England, 14 July 1994.

HILL, John M., Professor, "Violence and the Construction of Kinship: The Case for Wiglaf," South Atlantic Modern Language Association, Atlanta, Georgia, 10 November 1993.

HOWLAND, Mary D., Associate Professor, Workshop on Intimacy at the Al-Anon Conference, Chestertown, Maryland, 3 June, 1993.

JASON, Philip K., Professor, "Vietnam War Themes in Korean War Literature," Popular Culture Association, Chicago, Illinois, 7 April 1994.

JASON, Philip K., Professor, "The Men in Nin's (Characters') lives," Conference on Anais Nin, Southampton, New York, 28 May 1994.

LEFCOWITZ, Allan B., Professor, "Writing Dialogue," Shenandoah Writers Conference, Blue Hill, Virginia, November 1994.

MACE, Nancy A., Assistant Professor, "Fielding, Augustus, and the Maecenean Circle," East-Central American Society for Eighteenth-Century Studies, Towson, Maryland, 13 November 1993.

MACE, Nancy A., Assistant Professor, "Eighteenth-Century Music Publishing and the Law: The Cases of Charles Rennett," American Society for Eighteenth-Century Studies, Charleston, South Carolina, 13 March 1994.

McHENRY, Elizabeth, Assistant Professor, "The Origins of Two Writer-Ethnographers," Society for the Study of Southern Literature, New Orleans, Louisiana, 25 March 1994.

NAVRATIL, Joseph S., Lieutenant, USN, "The Forgotten War Poet: Alan Seeger," Popular Culture Association Meeting, Chicago, Illinois, 6 April 1994.

TOMLINSON, David O., Professor, "Trundling Down the Information Superhighway," Maryland Association of Departments of English, Bowie, Maryland, 5 March 1994.

TYLER, Eileen T., Associate Professor, "The Scriptural Matrix of Mary Gordon's *Final Payments*," Le Moyne Forum on Religion and Literature, Le Moyne College, Syracuse, New York, 16 October 1994.

WHITE, David A., Professor, "Swimming in Culture" and "Drowning in Culture," Traditional Catholic Conference, Holy Family Monastery, Berlin, New Jersey, 7-9 May 1994.

DEPARTMENT OF

History

Associate Professor Nancy W. Ellenberger
Chair

During Academic Year 1993-1994 a number of faculty in the History Department devoted their scholarly time to the National Endowment for the Humanities (NEH) Ethics Continuum Project. Scholars from across the country, with expertise in philosophy, classics, history, and literature presented public talks and small seminars to faculty interested in integrating ethics education into our curriculum. Seven faculty were involved in this year long project full time, while many others participated in different phases along with colleagues from around the yard.

Professor Culham's securing of the NEH Ethics grant was the largest source of outside funding received in the Department, but Associate Professor Robert Love also secured a large Department of Defense Legacy Fund grant to continue his work on Soviet naval archives. Associate Professor David Peeler was awarded a fellowship from the Huntington Library, and Associate Professor Griffin received another grant to pursue archival research in Richmond, Virginia.

Seven members in the Department published major scholarly articles in such journals as *Journal of American Studies, Classical Antiquity,* and *World Futures.* Associate Professor Michael Isenberg published the first of two volumes on the U.S. Navy Since 1945, *Shield of the Republic* (St. Martin's Press). Nine other faculty members gave conference presentations at national and international conferences. Many more presented scholarly talks to a variety of audiences and students alike.

History faculty use their scholarly expertise and insight to create a dynamic intellectual life for the department and the midshipmen. Most engage in the faculty Works-in-Progress seminar and in workshops on development of the core history courses. Nearly all have directed the research of History Honors students or conducted specialized seminars for majors. Thus research in libraries and archives that is pursued in solitude makes a vital contribution to the continued learning of colleagues.

Sponsored Research

History in the Mind of Lupus of Ferrières

Researcher: Assistant Professor David F. Appleby
Sponsors: National Endowment for Humanities
Naval Academy Research Council (OMN)

This study focuses on the sense of history discernible in the works of the ninth-century author, Lupus of Ferrières, in order to advance our knowledge of the way early medieval Europeans understood the past. Because the history of the historiography of the era of the Carolingian Renaissance is relatively uncharted territory, this research conducted over the last several years has centered on the historiography and sense of the past at the monastic school of Fulda, an important Benedictine house in the Carolingian realm whose school trained such important

historians as Einhard, Rudolf and Lupus of Ferrières. In October 1993, a paper titled "Memory of the Founder: The Sense of History at 8th- and 9th-Century Fulda" was presented by the researcher at the 18th Annual Great Lakes History Conference (Grand Rapids, MI). The present study is the next stage in this larger project. A study of Lupus' sense of the past will improve our understanding of historical awareness at Fulda and thereby contribute to our knowledge of how early medieval Europeans thought about their past.

The Transformation of a Regional Market:
Early Modern Paris and its Hinterland

Researcher: Associate Professor Thomas Brennan
Sponsor: Naval Academy Research Council (OMN)

This is a large-scale study of the early modern French wine trade. It charts the structure and evolution of supply networks and the changing role of merchants and brokers in the national and international market through the end of the old regime. In particular, it focuses on the economic relationship developed between merchants and producers, on the use of debt and monopoly to achieve economic control. Through their use of credit and information, their control of related fields of transportation and containers, and their management of the financial system, they attempted to dominate both ends of the market network. The researcher will investigate these processes at an individual level, using cases provided by judicial and notarial archives. The study also addresses the issue of linkages between different levels of markets and the impact of dynamic growth at the national level on the function of local producers. This project has resulted in several scholarly presentations and an article, "The Anatomy of Interregional Markets in the Early Modern Wine Trade," has been accepted for publication in the *Journal of European Economic History*.

Mary Boykin Chesnut and the Confederate Homefront

Researcher: Associate Professor Mary DeCredico Griffin
Sponsor: Naval Academy Research Council (OMN)

Mary Boykin Chesnut left one of the most remarkable diaries of the American Civil War. At turns witty and biting, but always prophetic, Chesnut catalogued the rise and fall of the Southern Confederacy from its birth at Montgomery to its death at Appomattox. As a member of the white elite of South Carolina, and as the wife of the man who became Jefferson Davis's military advisor, Chesnut had the unique opportunity to view the Confederacy from the top. Her diary is an excellent window into the world of the white elite during the war that literally destroyed their way of life. Chesnut's diary helps illuminate many aspects of the Confederacy behind the lines and thus furthers our understanding of that crucial period in American history.

This study has resulted in several presentations and will be published as a book for scholarly as well as general audiences.

Soviet Navy Archives Project

Researcher: Professor Robert W. Love, Jr.
Sponsor: Department of Defense Legacy Program

The Soviet Navy Archives Project aims to improve the documentation of the East-West naval competition and foster historical research on the Cold War naval rivalry by establishing in the West a repository for major documentary collections from archives holding records generated by the Soviet Navy. By negotiating an agreement with Russian naval and archival officials this project provides for the long-term exchange between the U. S. Navy and the Russian Federation of documents relating to Soviet naval policy, shipbuilding practices, strategic planning, tactical doctrine, and operations; and by supporting scholarly exchanges which improve our understanding of and encourage interest in the history of the major Cold War navies.

This year the Soviet Navy Archives Project sponsored the participation of several Russian Navy officials and Russian scholars at the Naval Academy's 11th Naval History Symposium. Academician Igor Spassky, the Director of the Rubin [Nuclear] Submarine Design Bureau, Captain First Rank Igor Amosov, Russian Navy, and Captain First Rank Georgi Sviatov, Russian Navy, delivered papers on Soviet Navy submarine policy and operations. Captain First Rank Boris Rodionov, Russian Navy, the editor-in-chief of the

forthcoming "History of the Russian and Soviet Navies," delivered a paper on the evolution of Soviet naval strategy and the strategic nuclear arms competition. These papers and supporting documents will be published in 1995.

With the support of the Soviet Navy Archives Project, the Naval Academy and the Russian Main Navy Staff, the Archives of the Russian Federation, and the Russian General Staff Military History Director are co-sponsoring a major international "congress" of historians and archivists in Moscow in September 1994 dealing with "The Navies and Strategic Nuclear Arms Competition in the Era of the Caribbean [Cuban Missile] Crisis." That conference will also be the site of an exchange of significant collections of recently declassified documents on the event.

Latin American Nikkei:
The Japanese Experience in Mexico and South America

Researcher: Professor Daniel M. Masterson
Sponsor: Naval Academy Research Council (OMN)

This project is now under contract with Westview Press of Boulder, Colorado and will be a 300-500 page monograph to be published in 1995. It is being co-authored with John F. Bratzel of Michigan State University and Sayaka Funada of Kobe University in Japan. Based upon research in six Latin American countries and numerous archives and libraries in the United States, it will examine the immigration and settlement of migrants from rural southern Japan and Okinawa during the late 19th century to the present day to Latin America. Patterns of community development, economic advancement and race relations with the diverse peoples of Latin America will also be examined for the period from 1920 to the present.

The Illuminating Mind in Twentieth-Century
American Photography

Researcher: Associate Professor David P. Peeler
Sponsor: Naval Academy Research Council (OMN)

This project is an examination of the growth of American photography in the twentieth century. It explores the ideas and values of leading American photographers, and the ways in which they brought those beliefs and values to fruition in their work. The project fills a gap in the existing scholarship, for while there is a substantial body of art criticism on the medium, there is little substantial scholarly treatment of the ideas associated with this broad swath of creative photography. This study's principal question is this: in what ways did these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their work that even the simplest fact cannot be presented without altering its "pure" objectivity in some way? This project was also supported by the Center for Creative Photography at the University of Arizona.

The Social Function of Dissertation Defenses
in Late Imperial Russia

Researcher: Assistant Professor J. Thomas Sanders
Sponsor: Naval Academy Research Council (OMN)

During a period as a Visiting Scholar at the Hoover Institution on a State Department Title VIII grant, the researcher discovered a previously unexplored realm of elite social life in late imperial Russia: the dissertation defense. These, it turned out, were gala public affairs whose social role was to affirm the class position of the educated elite vis-a-vis both the government and the lower classes. An article based on this research has been accepted for publication by the *Jahrbuecher fuer Geschichte Osteuropas.*

Hegel's Map of the Imagination

Researcher: Assistant Professor Chip Sills
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project is to develop an original theory of imagination based on a study of Hegel's *Science of Logic* understood as a systematic development of a new idea of "Concept"--an idea which includes the notion of "trope." At issue is the relationship between logical and poetic modes of construing evidence. Scheduled for research this summer are medieval notions of the tropological which may include a specific *ethical* twist. Study will ascertain whether Hugh of St. Victor's notion of the tropological--cited by Thomas Aquinas in his *Summa Theologiae*--extends to cover the notion of "conversion" or "periogoge" or "metanoia," terms which have historically included religious or philosophical senses of turning towards the good.

Rear Admiral Alan G. Kirk, the U. S. Navy, and Operation Overlord, 1944

Researcher: Midshipman 1/C Troy A. Shoulders, USN
Adviser: Professor Robert W. Love, Jr.
Sponsor: Trident Scholar Program

This narrative history constitutes the first scholarly account of the U. S. Navy's higher command in the planning, training, and operational phases of Operation Neptune, the naval aspect of the 6 June 1944 D-Day landings in Normandy. The work focuses on Rear Admiral Alan G. Kirk, who commanded the Western Task Force which landed and supported U. S. Army divisions on Omaha and Utah beaches. A superb choice for the billet, Kirk had served as Naval Attache in London during the Chamberlain and early Churchill cabinets and had commanded a task group in the 1943 invasion of Sicily. His immediate superior was the British Allied C-in-C Naval Expeditionary Force, Admiral Sir Bertram H. Ramsay, the hero of Dunkirk, and much of this history treats naval tactical problems involving both of the principal Neptune flag officers.

This history is divided into four main sections which detail the Anglo-American strategic argument over the cross-Channel strategy; tactical planning by Ramsay, Kirk, their subordinates, and their German opponents; assembling and training the American assault, support, and covering formations and forces; and, finally, the execution of the plan on 6 June. Controversies about the provision of U. S. Navy support ships, the danger of the opposing E-boat threat, the timing and position of the assault waves, minesweeping, gunfire support, supply methods, and the use of Ultra "special intelligence" are examined from a naval viewpoint for the first time.

The narrative is based on the Admiral Alan G. Kirk Mss., the Records of Task Force 122, and several other larger archival and privately held collections in Washington; the Admiralty Records at the Public Records Office, Kew, London, England; the Admiral Sir Bertram H. Ramsay Mss and Diaries held by the Churchill Archive, Cambridge University, England; Ramsay letters held by General Charles Ramsay of Bughtrig, Scotland; and interviews with Kirk's family and many ranking survivors of the admiral's D-Day staff.

The *Tarikh-i Alam'ara-yi Nadiri* of Muhammad Kazim Marvi

Researcher: Assistant Professor Ernest S. Tucker
Sponsor: Naval Academy Research Council (OMN)

The *Tarikh-i Alam'ara-yi Nadiri* is one of the major contemporary chronicles of Nadir Shah, ruler of Iran from 1736 to 1747. As one of the few extant accounts of an eyewitness to Nadir's era, it sheds light on what a contemporary observer thought about Nadir's attempts to legitimize his regime, and thus offers evidence concerning the evolution of concepts of political and religious legitimation in the period between the Safavid (1501-1722) and Qajar (1794-1923) eras in Iranian history. A careful reading and comparison of several versions of the text offers striking evidence of an attempt, not to justify the mere restoration or continuation of

Safavid rule, but to record the emergence of a new dynastic tradition which might reconcile the lingering power of Safavid legitimacy with the impact of Nadir Shah on Iran. This analysis helps fill in huge gaps in our understanding of the evolution of politics in Iran towards the modern era and the eventual Islamic revolution of 1979. An article summarizing the conclusions of this project will appear soon in the *Journal of Iranian Studies*.

Independent Research

Dictionary of Admirals of the United States Navy, Volume III, 1919-1941

Researcher: Associate Professor William B. Cogar

This research will produce the third of what will be a multi-volume series on all admirals of the United States Navy. This volume will be a continuation of the first and second volumes which covered the years 1862 through 1900, and 1901 through 1918. Like its predecessors, this volume includes biographical and career information. The intent is to provide the world of scholarship with a reliable and convenient source on American admirals which at present does not exist. This volume will be published by the U.S. Naval Institute Press.

An Encyclopedia of Naval History

Researcher: Associate Professor William B. Cogar

The Encyclopedia will provide a complete guide to world naval history from the fifteenth century, the beginnings of the age of sail and of the gun, to the present day, ending with two contemporary wars, the Iran-Iraq War and the Persian Gulf War. With over 1000 entries, arranged chronologically, it will be the most comprehensive work of its kind on the market. The researcher serves as a senior editor to the naval biography section. This volume will be completed in early 1994 and published by "Facts on File, Inc."

Roman Records

Researcher: Professor Phyllis Culham

Roman history to date has over systematized the fragmentary evidence for Roman law and administration. New anthropological work on premodern societies' use of writing allows us to re-envision the Roman past. The project will result in completion of a book manuscript. A number of articles on Roman use of records in particular situations has already appeared.

Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace

Researcher: Associate Professor Michael T. Isenberg

This two-volume work will present a history of the U.S. Navy since the end of World War II. Accepted for publication, the first volume appeared in 1993.

Educational Responses to Tailhook

Researcher: Professor David E. Johnson

The events that occurred at the meeting of the Tailhook Association in September 1991, raise serious ethical and educational issues. Of particular concern to an officer accession source like the Naval Academy are the educational efforts made to reduce the likelihood of a repeat of the Tailhook incident. The manner in which this concern is addressed is influenced by descriptions of what occurred at Tailhook. If these events were merely collective behavior a different type of remediation might be called for than if they resulted from deep seated misogyny. This project collected and analyzed varied descriptions of Tailhook, drawing particularly on Part I of the tailhook report of the Inspector General of the Pentagon, and proposes various educational responses.

Elections and the Political Communities of Colonial Virginia, 1728-1775

Researcher: Assistant Professor John G. Kolp

Elections to the eighteenth-century Virginia House of Burgesses have been of long-standing interest to historians because of the role they played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local county constituencies by a substantial proportion of the adult male population, it has never been clear what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between candidates? Were these events merely social gatherings or was something important being decided at these elections?

Initial case studies of three counties reveal the importance of tenants in the election process, the broad spectrum of issues colonial voters thought germane, the remarkable stability of voting behavior, the importance of previous officeholding to candidate success, and the role of local neighborhoods in defining electoral choice. Examination of surviving data on all elections for this period also reveal a pattern of gradual decrease in electoral competitiveness over the 50-year period, but also demonstrates substantial regional variation which does not fit traditional interpretations. Several new chapters are now being constructed and a book-length manuscript is being prepared for publication with Johns Hopkins University Press.

The Year of D-Day: The 1944 Diary of Admiral Sir Bertram H. Ramsay

Researcher: Professor Robert W. Love, Jr.

Admiral Ramsay holds a unique place in world history, being the only naval commander to have moved an army in combat both ways across the English Channel. The hero of the 1940 Dunkirk evacuation, Ramsay was always the unanimous British and American choice to command the navies when the Allies determined to re-enter the Continent in June 1944. Scion of a renown family of Scottish generals -- his grandfathers, father, elder brothers, and elder son were all general officers in the British Army -- Ramsay worked on a daily basis with Prime Minister Churchill, Generals Eisenhower, Bradley, and Patton, and Field Marshalls Montgomery and Alan Brooke from late 1943 until his tragic death at the end of the Battle of the Bulge in early January 1945. Found in his flight jacket, his personal diary for "the year of D-Day," clearly never intended for publication, was held until recently by his widow, Lady Ramsay, who agreed before her passing to lend it to the Churchill Archive at Cambridge University. Ramsay's sons graciously supported the annotation and publication of the diary, granted unprecedented access to an enormous collection of Ramsay's daily wartime letters to his wife which helped to clarify many issues, and provided unstinting assistance with lengthy interviews and repeated inquiries. Research in over a dozen British and American archival collections was necessary to explain and footnote many of the often cryptic entries. No other single wartime document provides such an intimate, daily portrait of the workings of the Allied higher command and the immense naval problems posed by Operation Overlord and the subsequent advance into Nazi-occupied Europe.

A book, co-edited by Professor John Major of the

University of Hull, comprising the fully annotated 1944 diary, biographical and bibliographical essays, a forward by the First Sea Lord, Admiral Sir Benjamin Bathhurst, photographs, and charts, will be published in Britain this spring and in the United States this summer as a tribute to one of the truly outstanding naval leaders of this century.

The Social Impact of AIDS in Africa

Researcher: Associate Professor Samuel H. Nelson

The AIDS pandemic poses an unparalleled threat to world health, particularly in the African continent where medical surveys have found the highest rates and greatest dispersion of viral infection. The AIDS crisis has generated a great amount of epidemiological research, but these otherwise laudable medical studies have tended to overlook the immediate and long-term impact of the epidemic on African society and culture. This project seeks to overcome this deficiency by undertaking a regional and detailed study of the social impact of AIDS in Africa. It will focus on AIDS victims, their families, and neighbors, using their own testimonies and experiences as indicators of social, economic, and cultural change. The approach will be both descriptive and analytical: it will retain the unique and personal African perspective of the epidemic as it also links aspects of social change to variations in daily experience rather than to general causation.

Discovering the Signs: Social Images of the Deaf Community in Nineteenth Century France

Researcher: Associate Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that created the deaf community in nineteenth century France. The researcher is focusing on the emergence of a deaf identity during a period of intense social change in western society. In the first part of the study, the revolutionary period is placed in perspective. The researcher is studying the concept of social deviance in terms of charity and public assistance. In the second part of the project, the researcher is studying the emergence of deaf community associations, initiatives for deaf education and the role of leading activists to improve the condition of deaf people. In the third part of the study, the researcher is looking at the uses of language and the exclusion of sign language from schools that educated the deaf in the late nineteenth century. In addition, the role of deaf-run congresses, deaf associations and newspapers will be analyzed to understand the emergence of deaf culture. The researcher has recently published a study of the deaf activist, Henri Gaillard, which has appeared in John Van Cleve's *Deaf History Unveiled: Selections from the New Scholarship*. In addition, the researcher has been invited to an international conference on deaf history to be held in Hamburg, Germany in October 1994.

The Origins of the Modern American General Staff

Researcher: Associate Professor William R. Roberts

Previous historians have argued that the American General Staff was patterned after the Prussian General Staff in order to make the American army a more effective fighting force. This research, however, has lead to the conclusion that the staff reforms introduced at the beginning of the twentieth century represented the culmination of a long-standing struggle for power between line and staff officers as well as another struggle for power between the secretary of war and the nineteenth-century commanding general. Supporters of the creation of the General Staff in 1903 wanted to strengthen the secretary and the line as much, if not more, than they wanted to improve the fighting skills of the army. Their reforms provided a foundation for the growing bureaucratization of the military establishment in this century. The final product of this research is to be a monograph already accepted for publication by Greenwood Press.

Soviet Naval Archives Project

Researcher: Assistant Professor Thomas Sanders

This project is designed to get into scholarly and public circulation significant documents relating to Soviet naval history. To that end, Dr. Sanders has established working relations with archivists and historians at the Rossiiskii gosudarstvennyi arkhiv Voenno-Morskogo Flota (Russian State Naval Archive) in St. Petersburg and with the Institute of Military History. In addition to archival research and consultation in Russia, Dr. Sanders has consulted with Western experts at the Hoover Institution and Stanford University and has recently participated at a conference at Yale University. The project suffered a grievous blow with the premature death at age 49 of the main Russian participant, Dr. Alexander Ioffe. Negotiations are underway to move the project forward through other means, for which Dr. Sanders has received a grant from the National Endowment for the Humanities.

Hegel and Voegelin: the Battle over Gnosticism

Researcher: Assistant Professor Clarence (Chip) Sills

Eric Voegelin (1901-1985) was one of the most profound critics of the modern age. His influential diagnosis of modernity as fundamentally "gnostic" in outlook involves a specific criticism of Hegel as the great "speculative gnostic" philosopher of modernity. This work on the tropological dimensions of Hegel's work enables a new look at the problem of whether or not Hegel is properly viewed as a "gnostic," and to what extent Voegelin's criticisms are valid. The researcher was invited to organize a panel discussion on this topic for the upcoming Annual Convention of the American Political Science Association (September 1994), and is preparing a contribution to this panel.

University and Ideology in Sixteenth Century France

Researcher: Assistant Professor James V. Skalnik

Dramatic changes in the economic and social order in France in the mid-sixteenth century prompted equally dramatic changes in the nature of the University of Paris, Europe's leading educational institution up to that time. Previous research has established the extent to which policies on faculty recruitment, admissions, and financial aid to students altered to reflect the new social realities. To complete our picture of an early modern university in transition, it is necessary to investigate changes in the official ideology of the university, as revealed in its mandated curriculum as well as in its relationships to the reformed Catholic Church and to the emerging absolute monarchy of France.

An Atlas of American Naval History

Researcher: Professor Craig L. Symonds

This project is intended to produce a useful atlas depicting the major events in American Naval history from 1775 to the present. It will contain 154 full color maps (charts) accompanied by an explanatory text keyed to the maps.

"Stonewall of the West":
The Life of Confederate Major General
Patrick Ronayne Cleburne

Researcher: Professor Craig L. Symonds

This research will result in a full-length biography of Major General Patrick R. Cleburne, an Irish-born Confederate general in the American Civil War. In addition to his reputation as one of the best, if not the best, of the Confederate division commanders, Cleburne is best known for advocating the emancipation and arming of southern slaves to fight for southern independence.

A Topical History of the Third Reich

Researcher: Professor Larry V. Thompson

Research is being conducted for a book-length synthesis of National Socialist Germany. Topically organized, the study is both interpretive and derivative. It seeks to demonstrate the experience of everyday life under National Socialism while documenting the extent of polycratic rather than dictatorial rule exhibited by the regime. Based upon extensive archival research and current scholarship over the past quarter century, the book, when completed, will contribute to the continuing scholarly debate on whether or not the Nazis were functionalists or intentionalists in program and practice.

Research Course Projects

Domitius Corbulo's Armenian Campaigns

Researcher: Midshipman 1/C Robert E. Gentry, USN
Adviser: Professor Phyllis Culham

Nero sent Domitius Corbulo to the Near East at a time when tensions between the Roman and Parthian Empires were escalating rapidly. Corbulo did not contribute to this escalation. His subsequent campaigns were narrowly directed at solving the crisis over Armenia in a fashion which would be likely to secure stability and peaceful coexistence on the Roman--Parthian border. In spite of Roman sources which identify him as the last of the heroic-model, hard-charging generals of the Roman Republic, Corbulo's actions in Armenia show him to be an exemplar of the Imperial policy of seeking stable frontiers. One version of this project was read at a meeting of the Classical Association of the Atlantic States in 1993, and work continues to revise the paper for publication.

Paiderastia in Greek Elite Military Units

Researcher: Midshipman 1/C Kylan A. Huffman, USN
Adviser: Professor Phyllis Culham

Many distinguished scholars have written on elite military units in ancient Greece, and an ever-increasing number of social historians have attempted to explain the role of homoeroticism in Greek society. This study is the first to explain the literary anecdotes which ascribe homoeroticism to certain elite military units. The very formation of such units apparently was an effort to integrate the archaic Greek aristocracy into the increasingly homogenous and therefore increasingly deomcratic hoplite armies of the classical polis.

Homoeroticism was one facet of the ethos of that elite, and service in elite units served to legitmate that ethos and integrate the aristocratic elite into the democratic polis. The first paper resulting from this project won first place in regional Phi Alpha Theta competition and has additionally been submitted to the panel awarding the 1994 John J. Winkler prize in the social history of antiquity.

Ancient Philosophy as Guide to Contemporary Political Thought

Researcher: Midshipman 1/C Ward A. Jones, USN
Adviser: Assistant Professor Chip Sills

Leo Strauss and Eric Voegelin have recently argued for the continuing relevance of classical philosophical and political thought for the analysis of modern situations and for help in identifying alternative strategies for political action. This HP496 project relies upon a survey of works from Plato and Aristotle in the classical tradition, and Michael Oakeshott and Eric Voegelin among contemporary theorists, to develop categories for analyzing the current situation of "ethics instruction" at the U. S. Naval Academy in the aftermath of the December 1992 Electrical Engineering cheating scandal and its investigation process.

The Falklands/Malvinas War in Strategic Perspective

Researcher: Midshipman 1/C Ramon I. Lamas, USN
Adviser: Professor Daniel M. Masterson

The 1982 Falklands/Malvinas War between Argentina and Great Britain has been analyzed from an operational view quite extensively. What is lacking in the scholarship on this topic is an analysis of the Argentine military's strategic objectives in initiating the war. Relying upon an extensive review of the secondary literature, Argentine military journal literature, and historical documentation in the United States National Archives, this project will offer an analysis of the Argentine Navy's historical vision of a South Atlantic presence and its relation to the Falklands/Malvinas conflict.

Albemarle County, Virginia, 1850-1865:
A Community Study Through the Eyes of Louisa H. A. Minor

Researcher: Midshipman 1/C Blake Hunter Phillips, USN
Adviser: Associate Professor Mary DeCredico Griffin

Louisa H.A. Minor and her family lived on a sizeable plantation near Monticello. Raising livestock, grain, and other crops, the family prospered throughout the antebellum era; on the eve of the Civil War, it ranked among the country's most prosperous plantations. Minor's diary, kept throughout the antebellum and wartime periods, provides a unique window into the life of a member of the Virginia plantation elite during its most tumultuous test: Civil War and Reconstruction. Minor's diary allows us to gauge the impact of the war upon the elite, and especially upon women of that social class. Her recollections testify to the determination and sacrifice of Southern women and demonstrate that they moved off of their pedestals to participate actively in the Confederate war effort. This paper received honors in history and will be revised for publication.

"Fighting for Survival": The Effect of the American Civil War on the United States Marine Corps

Researcher: Midshipman 1/C Brian Anthony Ross, USN
Adviser: Associate Professor Mary DeCredico Griffin

The U.S. Marine Corps has a proud heritage dating back to its founding in 1775. Yet, it did not always perform up to its much vaunted reputation. Indeed, the years of the Civil War found the Marine Corps without a clearly defined mission and subject to two separate proposals for abolishment. But the Corps survived these challenges largely because they did perform honorably as ship's guards and as gunners. Because of their success in those two areas, the U.S. Navy's high command succeeded in deflecting those Congressional proposals to abolish the Corps or transfer it to the Army. In the aftermath of this fight for survival, the Marine Corps reassessed its mission and goals. What emerged from this process was a renewed emphasis on training that emphasized amphibious assault.

Severus in the East

Researcher: Midshipman 1/C Kenneth C. Weller, USN
Adviser: Professor Phyllis Culham

Septimius Severus' two invasions of the Parthian Empire at the end of the second century A.D. serve as a case study contributing to a current historiographic debate over whether or nor the Roman Empire was capable of conceptualizing and enacting a consistent security and frontier policy. Severus apparently did formulate such a policy toward the rival Parthian Empire and did attempt to redesign the Roman/Parthian frontier in order to secure Roman interests. This lends credence to Brookings analyst E.N. Luttwak's belief that Roman security policy is a sophisticated model worth considering by the U.S. and by U.S. led coalitions. This analysis resulted in a paper which won third prize in the regional Phi Alpha Theta competition. A longer version of the paper is being prepared for publication.

Publications

CULHAM, Phyllis, Professor, "Romans, Greeks, and Delmatae: Reconstructing the Context of RDGE 24," *Classical Antiquity* 12 (1993), 51-64.

Recent scholarship has ascribed the fragmentary document known as RDGE 24 to an embassy from Salonae in Dalmatia protesting to Julius Caesar some infringement of their commercial rights by Roman settlers on the Dalmatian coast. Actually, a close reading of the text, combined with careful efforts to recover the local Dalmatian context indicates that Romans and Greeks alike, in and around Salonae, were asking Caesar for help with the indigenous Delmatae. This has implications for the study of Greco-Roman urbanism and intrinsic effects on herding peoples, for the transmission and revival of Roman governmental records, and for the study of Greek maritime and commercial interests on the Dalmatian coast.

GRIFFIN, Mary DeCredico, Associate Professor, "Economy," "William Gregg," "Impressment," "Speculation," "State Socialism," "Substitutes," "Tax-In-Kind,""Confederate Sequestration," in Richard N. Current, ed.-in-chief, *Encyclopedia of the Confederacy*, 4 vols. New York: Simon & Schuster, (1993).

Each of these topics represents an article on one aspect of the Confederate States of America during the period from 1861-1865. William Gregg was a textile manufacturer and entrepreneur; speculation dealt with profiteering on the homefront; substitutes were ersatz measures; sequestration detailed the Confederate policy of seizing Federal property; state socialism marked the status of the Confederate economy by 1864; the tax-in-kind, passed in 1863, stipulated that Southerners had to pay a tithe of ten percent on all agricultural products; and the economy article dealt with all major elements of the Confederate

economy during the war.

PEELER, David P., Associate Professor, "The Art of Disengagement: Edward Weston and Ansel Adams," *Journal of American Studies* 27 (December 1993), 309-334.

These two American photographers were good friends, and shared both political outlooks and aesthetic perspectives. In the formative years of their lives, and continuing into the social crises of the 1930s, they avoided political commentary in their work. But then during the crush of World War II they embraced activism, Weston creating images demonstrating his hatred of fascism and ambivalence about war, while Adams attacked domestic American shortcomings such as the internment of Japanese-American citizens.

PEELER, David P., Associate Professor, "Again, the Thirties," *American Quarterly* 46 (March 1994), 107-113.

There is a continuing, vital scholarship of American culture from the Depression years, and this review article discusses four recent contributions to that scholarship. Common themes include gender issues, agressive political imagery, and the dissolution of progressive movements. There is also a strong cautionary element, with a shared sense that lessons of the 1930s may be particularly valuable in the 1990s.

QUARTARARO, Anne T., Associate Professor, "Republicanism, Deaf Identity and the Career of Henri Gaillard in late nineteenth century France," ed. John V. Van Cleve, *Deaf History Unveiled: Selections from the New Scholarship*. Washington: Gallaudet University Press, (1993), 40-52.

This study focuses on the early adult life of the deaf activist Henri Gaillard and his paradoxical relationship with the liberty-loving republicans in France during the 1890s. The researcher connects the education policies of Jules Ferry and compares these professed government objectives to the treatment of deaf people. While the republican policy-makers were committing more financial resources to public schooling, they did not make the same efforts for the deaf. Gaillard took the

opportunity through his writings and his attendance at international conferences for the deaf to point out this paradox. Because he advocated deaf rights in a republic based on equality before the law, Gaillard stood at the forefront of proponents who associated educational opportunity with social progress.

QUARTARARO, Anne T., Associate Professor, "Integration or Segregation: The Dilemma of the French Deaf Community and the the Goals of Republican Education, 1880-1900," ed. Norman Ravitch, *Proceedings of the Western Society for French History.* Riverside, California: University of California, (1993), 315-323.

The purpose of this article was to study some of the educational goals of the Third Republic in France and discuss how these objectives affected the French deaf community between 1880 and 1900. The author first gives some background about the state of deaf education at mid-nineteenth century and then considers how deaf schooling fit into the larger republican scheme for national integration. The article shows that the moderate republican leadership of the Third Republic pursued a contradictory relationship with the French deaf community. Republicans understood little about French sign language and refused to give "sign" any status in deaf education. For the deaf, the relationship with the Third Republic underscored their frustration as they remained second-class citizens.

SANDERS, T. John, Assistant Professor, "The Third Opponent: Dissertation Defenses and the Public Profile of Academic History in Late Imperial Russia," *Jahbuecher fuer Geschichte Osteuropas* Heft 2, 41 (1993), 242-265.

Based on research funded in part by a Naval Academy Research Council grant, Dr. Sanders has published an article analyzing the role of public dissertation defenses as a social support mechanism for the isolated, educated elite of late imperial Russia. The article demonstrates the autonomy of civil society in transforming a state-dictated public spectacle into its own social mechanism. At the same time, this research confirms the isolated and exposed nature of the educated elite vis-a-vis the common people of the tsarist empire.

Presentations

GENTRY, Robert E., Midn. 1/C, "Domitius Corbulo and the Armenian Frontier," fall meeting of the Classical Association of the Atlantic States, Annapolis, Maryland, 20 October, 1993.

HAGAN, Kenneth J., Professor, "The Current State of Naval History in the United States," Yale University/Naval War College Conference, New Haven, Connecticut, 17 June 1993.

JOHNSON, David E., Professor, Commencement Address, entitled "By Whose Authority", St. John's College Graduate Institute, St. John's College, Annapolis, Maryland, 6 August, 1993.

JOHNSON, David E., Professor, "Tailhook: A Failure of Authority," Conference on The Moral Dimensions of Leadership, North Central College, Naperville, Illinois, 30 September, 1993.

JOHNSON, David E., Professor, "Ethical Education in the Military: Controlling the Institution of Violence," Sixth Annual Meeting of Concerned Philosophers for Peace, Hamline University, Minneapolis, Minnesota, 8 October, 1993.

JOHNSON, David E., Professor, "Is Competitiveness Essential to a Complete Human Life?" at the 22nd Conference on Value Inquiry with the theme "Conflicting Values", Drew University, Madison, New Jersey, sponsored by the Society on Value Inquiry, 21 April, 1994.

MASTERSON, Daniel M., Professor, "The Later Imin: Japanese of Bolivia and Paraguay," Great Lakes Historical Conference, Grand Rapids, Michigan, 5-6 October 1993.

MASTERSON, Daniel M., Professor, International Maoism and the Future of Peru's Shining Path, Industrial College of the Armed Forces, Washington, D.C., 8 November 1993.

PEELER, David P., Associate Professor, "Apocalyptic Artist: Paul Strand in Mexico," Washington Seminar on American History and Culture, Washington, D.C., 5 May 1994.

SANDERS, J. Thomas, Assistant Professor, "The Soviet Naval Archival Project," Conference on Russian and East European Archives, Yale University, New Haven, Connecticut, 6 January 1993.

SILLS, Clarence (Chip), Assistant Professor, "Contemporary Religion as Therapy," Salisbury unitarian Fellowship, Salisbury, Maryland, July 1993.

SYMONDS, Craig, Professor, "Joseph E. Johnston and the Defense of Richmond," Richmond Civil War Round Table, 14 September 1993.

SYMONDS, Craig, Professor, "The End Game: Confederate Strategy in North Carolina, 1865," National Congress of Civil War Round Tables, Wilmington, North Carolina, 12 October 1993.

SYMONDS, Craig, Professor, "Jefferson Davis and Joseph E. Johnston: A Case Study in Civil-Military Relations," The Annual Martin Lecture, Texas A&M University, 26 October 1993.

SYMONDS, Craig, Professor, "Leadership and Moral Courage at Gettysburg," New York Civil War Round Table, New York City, 10 November 1993.

SYMONDS, Craig, Professor, "Joseph E. Johnston and the Defense of Atlanta," Atlanta Civil War Round Table, 15 February 1994.

SYMONDS, Craig, Professor, "Civil War in the Confederate Government: Davis, Johnston, and Wigfall," Annual Meeting of the Society of Military History, Washington, D.C., 9 April 1994.

SYMONDS, Craig, Professor, "The Morality of Command: The Surrender at Bentonville," Ceremony to Commemorate the Anniversary of the End of the Civil War, Bennett House State Historic Site, Durham, North Carolina, 17 April 1994.

SYMONDS, Craig, Professor, "'If Slaves Make Good Soldiers...': Black Soldiers in the Civil War," Banquet Address, Delaware Valley Conference on Civil War History, Delaware State University, 21 May 1994.

SYMONDS, Craig, Professor, "Leadership and Moral

Courage in the Battle of Gettysburg," Address at the Army and Navy Club, Washington, D.C., 26 May 1994.

SYMONDS, Craig, Professor, "April 1863: Two Case Studies of Combined Army-Navy Operations," Deep Delta Civil War Symposium, Southeastern State University, Hammond, Louisiana, 2 June 1994.

TUCKER, Ernest S., Assistant Professor, "The Ottomans in the Caucasus, 1720-1750: The Case of Daghestan," Annual Meeting of the Middle East Studies Association of North America, Research Triangle Park, North Carolina, 19 November 1993.

Language Studies

Professor Sharon Dahlgren Voros
Chair

The Language Studies Department enjoyed a very strong year, with outstanding classroom and scholarly performance by faculty. Faculty members produced 16 articles on French, Spanish, Russian, and German philosophical, cultural, and literary topics and gave more than 20 presentations at national and international conferences.

In the field of language acquisition, the Annapolis Interactive Video Project continued to create interactive video lessons for French and Spanish, and established plans to develop lessons for Japanese and German. This project won a grant from the National Security Agency for Chinese.

The department has enjoyed strong enrollments in all languages and successfully expanded the Cox/Graubart overseas program and internship opportunities at U.S. embassies in France and Spain. We are proud of the large number (116) of minors in all languages among 1994 graduates who have elected to pursue language, literature, and area studies at advanced levels. These graduates will bring to the Navy and Marine Corps not only valuable linguistic skills but also in-depth knowledge of the regions where a specific language is spoken.

Sponsored Research

Annapolis Interactive Video Project

Researchers: Associate Professor William H. Fletcher,
Project Director, Instructor Yumei Sun,
Assistant Professor Christopher Buck, and
Professor John Hutchins
Sponsor: National Security Agency

Since its inception in 1985, this project has expanded into a team of professors who compile videodiscs and develop interactive video (IAV) lessons for Spanish, French, Russian, German, and Chinese. Project members have developed delivery and written software for a standard approach to creating lessons, and they have also produced extensive documentation to guide authors through the process. Authors combine selections from a set of some twenty presentation and exercise template types into a lesson structure and provide lesson content in text, graphic and "control" (script) files produced with USNA-developed writing tools and commercial graphic software. The project team regularly shares its software and its IAV expertise with other Naval Academy departments, government agencies, and educational institutions.

Currently over 700 midshipmen are benefitting from some 140 IAV lessons in four languages. A new 47-station multimedia facility in Nimitz Library affords midshipmen access to IAV whenever the library is open, greatly increasing the potential number of student learning sessions per week. An initiative in progress will add 36 networked digital video stations to that number to eliminate the expense and delay of videodiscing. This is the next step toward the long-term goal of distributing IAV lessons to midshipmen in their rooms in Bancroft Hall via the Naval Academy Data Network.

Drastic cuts in outside support for the project and virtual elimination of institutional funding from summer salaries have resulted in a dramatically reduced level of videodisc compilation and lesson development. Current lesson development efforts are limited to the production of videodiscs and interactive video- and print-based lessons for learning Chinese. The possibility of distributing these materials and other software and courseware developed by project members in such a way that revenues generated will permit the project to return to its former level of productivity is being investigated.

The Annapolis Interactive Video Project continues to expand the scope of its internationally recognized

pioneering work. Under a grant from the Fund for the Improvement of Post-Secondary Education (Department of Education), the project has been collaborating with Southwest Texas State University to complete development of multimedia lessons by writing templates for IBM-compatible hardware similar to ones already available for the Macintosh. In summer of 1993, USNA hosted one of three week-long workshops for authors organized under this grant, bringing language instructors from throughout the country to Annapolis. Plans for similar workshops in the future depend on the availability of outside funding.

Chantal Chawaf: A Plea for New Ethical Values in Literature

Researcher: Assistant Professor Marianne Bosshard
Sponsor: Naval Academy Research Council (OMN)

The goal of this project is to rewrite and update a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary French women novelists. To date, no comprehensive critical analysis is available on this author, either in French or in English.

Literature produced by French women writers conscious of their sexual identity has recently entered a new phase which can best be summarized, in Hélène Cixous' words, as a "mission éthique," a new relationship between the ethical and aesthetic aspects of "l'écriture." Chantal Chawaf's most recent publications clearly demonstrate this change. In this sense, her latest works reflect certain contemporary discourses in the field of sociology, post-freudian psychoanalysis, and contemporary "post-deconstructionist" philosophy which emphasizes the need for new ethical values governing the symbiotic relationship between mankind and nature.

Since the beginning of her literary career in 1974, Chawaf has always been known as an "écrivain engagé" and often was, mistakingly, labeled a "feminist writer." What is needed is a more accurate and up to date interpretation of the changes that occurred in her work during the past few years, a change that was not reflected in the previous research leading to the doctoral thesis by the researcher on Chawaf's oeuvre.

Minority Figures in Spanish Golden Age Short Plays

Researcher: Associate Professor Maria E. Castro de Moux
Sponsor: Naval Academy Research Council (OMN)

The objectives of this project were to explore the current bibliography on short plays of the Baroque Era, to read and photocopy seventeenth and eighteenth century original printings of short plays not available in modern editions, and to gather historical data to support the preparations of publishable materials on marginal discourse in Spanish Theater.

An extensive bibliography of seventeenth century authors and short plays of the Baroque Theater was gathered. The researcher is currently in the process of analyzing this data. Part of this analysis resulted in a paper entitled "La gitana picara y el criado flematico: Sobre el *Entremés de Pedro Hernandez y el Corregidor*," presented at the Fourtheenth Golden Age Theater Symposium at the University of Texas, El Paso, in March of 1994.

Flaubert's Fictional Escape into Immobility

Researcher: Professor Eva L. Corredor
Sponsor: Naval Academy Research Council (OMN)

The objective of this study was to identify Flaubert's literary efforts to overcome romanticism and to demonstrate his desire to adopt a scientifically precise, impassive way of writing which ultimately led him to favor and create narrative forms of immobility.

A systematic screening of Flaubert's novels yielded lists of examples to document the novelist's increasing tendency toward immobility. In *Sallambô*, for instance, it seems to have dictated the plasticity of landscapes and the predilection for a pose (or "tableaux") in portraying the main character. Emma Bovary's romanticism and nervous states are like schizophrenic spinnings of the mind which,

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like her boundless desires, seem driven around a vicious circle from which there is no escape. From a reading of Flaubert's letters to Louise Colet, one learns of his wish to experience reincarnation in plastic form and of his constant longing for death. Flaubert's dream of a "book about nothing," a work of pure style and literariness, was examined through Peter Buerger's theories of the autonomy in art, Terry Eagleton's sociocritique, and psychoanalytic theories inspired by Freud and Lacan. Such literary and critical investigations provided insights into Flaubert's troubled vision of reality, his irrational wish to escape the perceived imperfections of modern society, and his surrender to the mirage of science which characterized the mood of his romantic age.

Some results of this research have led to a presentation of "The Seductions of Realism," to be published by New Paradigm Press in a collection of essays on the French novel. Other parts have been incorporated into a review essay on "The Ambiguity of the Status of Art," forthcoming in *New German Critique*.

Aspects of Basque

Researcher: Instructor Ana I. Echavarri-Daily
Sponsor: Naval Academy Research Council (OMN)

In Linguistics, the theoretical framework which has come to be known as the principles and parameters approach which was introduced by Chomsky in *Lectures on Government and Binding* (1981) concentrates on the general principles, constraints, and parameters that might indicate how language acquisition takes place. The Government and Binding model (G.B.) is based on the belief that language is a cognitive system, which is in large part innate and, as such, part of our biological endowment. This concept of language motivates the quest for the principles on Universal Grammar (U.G.) that form part of our ability to create language.

The topics of the Ph.D. dissertation "Aspects of Basque Syntax" are studies of grammatical constructions in Basque which exhibit peculiar behavior, uncommon to other languages, and therefore are difficult to explain within the G.B. model. One of those aspects is "Focus in Basque." The relevance of focus in the structure of the Basque language was first noted by Severo Altube. In his book, *Erderismos*, he noted that in Basque, the focused element of a sentence must be placed immediately before the verb. Current linguistic research, building on this study, has concentrated solely on postulating a preverbal syntactic position to where the focused element must move in Basque. This approach ignores other focusing strategies, and so far has not been able to explain the problem of focus in negative sentences.

In the past, the researcher observed that in addition to the main focusing strategy mentioned by Altube and others, there are other strategies, similar to the ones used in Spanish or English that are also common to Basque: right dislocation, left dislocation, and in some cases, postverbal placement of the focused element. The researcher concentrated on the type of focused elements that can be placed postverbally.

The researcher also provided an explanation for focus in Basque negative sentences, a persistent problem for any analysis that proposes a unique syntactic preverbal focus position. In Basque negative sentences, the focused element is placed postverbally, but before the inflected auxiliary. The researcher believes that there exists a second position in Basque, reserved for contrastive purposes, and that it is to that position that focused elements in negative sentences must move because of their contrastive nature.

For the study period ending in 1993, the researcher provided a syntactic analysis for certain verb focusing strategies, while other strategies were explained functionally. Through the study of novels and plays, the researcher elucidated the use of the "egin" verb focusing particle in two dialects and proposed a functional explanation for its use.

Recently, there has been an important change in the G.B. theory. This change concerns a proposal Chomsky made eliminating the need for Deep Structure. With this change many of the mechanisms used to explain certain linguistic structures and structural movement based in a multilevel representation became obsolete. Although the bulk of the research for this dissertation has been completed, the researcher is now in the process of studying the changes mentioned above, and updating the theoretical explanations used in the dissertation to the new developments in the theory.

Text Comprehension and Foreign Language Reading:
Theory and Practice

Researcher: Assistant Professor Elizabeth M. Knutson
Sponsor: Naval Academy Research Council (OMN)

Through an analysis of reading comprehension and textuality which draws from a number of different research disciplines, this study explores issues relating to literacy and reading instruction in the areas of foreign language and literature. The disciplines drawn upon in this study include educational and cognitive psychology, first and second language acquistion, ethnography, text linguistics, and literary criticism. In combination the perspectives offered by these different fields enrich researchers' understanding of readers, texts, the reading process, and the social, academic context in which reading instruction takes place. The study focuses on four basic components of the comprehension and interpretation process--text, reader, task, and help--and explores related issues and concepts which have been raised in the multi-disciplinary literature on textuality and reading as a socio-cognitive practice. Two articles were written during the past year. The first focuses on the issue of text difficulty, and the second focuses on reader-based factors, exploring the concepts of cultural and literary competence and reader literacy.

Second Language Acquisition of English Reflexives by Japanese
Speakers and Japanese Reflexive "Jibun" by English Speakers

Researcher: Instructor Chiyo Myojin
Sponsor: Naval Academy Research Council (OMN)

The researcher investigates how native speakers of Japanese learning English acquire English reflexives and also how native speakers of English learning Japanese acquire the Japanese reflexive "Jibun" by extending Manzini and Wexler's (1987) parameter setting model for first language (L1) acquisition to second language (L2) acquistion.

The researcher, therefore, examines how Japanese learners of English and English learners of Japanese set values of the governing category parameters. The investigation continues to determine whether learners observe the Subset Principle (Berwick 1985) and succeed in acquiring the correct L2 value, or whether they unsuccessfully transfer their L1 value to the L2 grammar, or adopt a value which is that of neither the L1 nor the L2. Even though the Subset Principle is not applicable to L2 acquisition, it seems that Universal Grammar (U.G.; Chomsky 1981, 1986, 1989) is still applicable. Thus, this finding would support Manzini and Wexler's (1987) hypothesis that although the learning principle and UG are in different modules, they are interacting with each other.

Independent Research

The Pragmatic Exploitation of the Impersonal [se]-Structure
in Spanish Oral Discourse

Researcher: Associate Professor Penelope M. Bledsoe

The researcher is preparing a book in Spanish linguistics on structures associated with the Spanish impersonal pronoun [se]. The bibliography of syntactic and semantic studies of this structure is quite extensive; however, these studies have been inconclusive as to the variability of the form of the structure itself, factors which determine its form, and contexts of occurrence of the form. The researcher has found that the form of the structure is influenced by factors determining distribution of information in the Spanish clause, not strictly by a

syntactic movement rule. The choice of one form of the structure over another depends on how the structure is to be used in context. In a pragmatic framework, the study explains the apparent anomalous occurrence of the impersonal-[se] structure in contexts where a definite referent would be expected. It was found that in certain social and cultural contexts it occurs to sustain sociolinguistic principles of communication where polite and formal language prevails. It occurs as an effort of the language user to shift responsibility and/or blame away from a logical subject.

Four chapters on the structure have been completed. The researcher did field work in Spain in the summer of 1992 to collect data for another chapter of the proposed book. From this date, she is currently preparing a paper on women's use of the impersonal pronoun to express opinion. The presentation of a paper based on the analysis of the data obtained by interview has been accepted and will be given at the Northeast Conference of the American Association of Teachers of Spanish and Portuguese at Yale University in October, 1994, and will be published separately as an article in the *Georgetown Journal of Languages and Linguistics*. It also will appear as chapter 5, "The Occurrence of the Impersonal-[se] in Spoken Discourse," in her book-length study on the [se]-structure in Spanish.

Subject Inversion in Spanish and Narrative Style: A Case Study of *Los de abajo*

Researcher: Associate Professor Penelope M. Bledsoe

The proposed functional value of subject inversion in Spanish is that of focusing the subject noun phrase. This non-contrastive and non-emphatic subject focus is achieved by placing the subject noun phrase in clause-final position, where it is appropriately highlighted by normal sentence stress. The typical clause configuration resulting from this inversion is: (temporal or spatial adverb) + verb + subject noun phrase + (postmodification). In a discourse, the function of this construction, sometimes referred to as "existential" or "presentational," has been identified by Hatcher, 1954; Contreras, 1978; and Suner, 1984, as asserting the existence of subject.

The researcher addresses the function of the focused subject noun phrase and the existential or presentational clause of which it forms a part in a narrative. By examining its occurrence in "Los de abajo," it is shown that this construction with a postposed subject brings subject noun phrases, both animate and inanimate, into focus as simply being or existing. The verbal and adverbial phrases simply serve as devices for getting the subject noun phrase onto the scene and situating it in time and space. Passages from the novel are used to illustrate this function. In particular, it is shown how Azuela exploits this structure in a narrative replete with action and violence to slow down the action and give the reader a respite in a world he paints as otherwise peaceful and beautiful with splendid descriptions of vistas and sound. The author "paints" scenery with the construction exactly as Hatcher describes in her seminal study of the existential sentence.

The results of this research were presented at the Northeast Regional Conference of the American Association of Teachers of Spanish and Portuguese at St. Anselm College, New Bedford, New Hampshire, September 1992. The revised paper has been accepted for publication in the Proceedings of the Conference.

Women's Speech Patterns in Expressing Opinion: A Case Study in Spain

Researcher: Associate Professor Penelope M. Bledsoe

This study is part of an ongoing research project on women's speech in Spanish. It addresses the ways in which women express opinions on potentially sensitive topics, topics which in some way involve them directly, either personally, professionally or culturally. The directness versus indirectness of their responses and the linguistic structures employed to express their opinions is the primary focus of this project.

It is hypothesized that women's speech in general is much more direct in Spain than it has been reported to be in the United States, both in requesting and in expressing opinons. Studies of women's speech in the United States will be used as a source of comparison to gauge directness of response based on the occurrence of

qualifiers, tag questions, hedges and impersonal statements; therefore, the study is also cross-cultural.

The data was gathered in Salamanca, Spain, during the summer of 1992. The forum was pre-arranged interview although the interviews often developed into informal conversations. Informants were middle-class, educated women with careers. They were told that the researcher was conducting linguistic research; however, the exact nature of the research was never revealed.

The results of this research have been accepted for presentation at the Northeast Conference of the American Association of Teachers of Spanish and Portuguese at Yale University in October of 1994.

Student-Teacher Interaction and the Use of First Language (L1) in the Foreign Language Classroom

Researchers: Associate Professor Penelope M. Bledsoe and
Assistant Professor Elizabeth M. Knutson

This research seeks to define the function of spoken first language (L1) in the foreign language classroom as perceived by instructors and adult students. The researchers hope to discover when and why students and/or instructors feel the need for interaction in the native language of the student. Current foreign language pedagogy recommends and would require all communication between instructor and student be in the target language. Even though this may be possible, linguistically speaking, how does the exclusive use of the target language in the classroom affect attitudes of the language users toward one another? In order to address these questions, faculty questionnaires and student surveys have been designed and prepared by the researchers and have been administered to all foreign language instructors at the Naval Academy and all students of the intermediate level. The researchers will examine the question of the use of L1 in the foreign language classroom as defined by a number of methodologies and will analyze the results of their own questionnaires and surveys in order to determine factors perceived to influence language preference for classroom interaction between instructor and student and among the students themselves. The results of this research project will be presented at a professional conference in the spring of 1995 and will be submitted to *The Modern Language Journal* for publication.

Annie Cohen: In Search of Water, Origins, Memory and Hidden Meanings

Researcher: Assistant Professor Marianne Bosshard

Annie Cohen is a contemporary French author and artist who, since 1980, has published five novels and numerous poetic texts that include her artistic works such as gouaches and "rouleaux d'écritures." For this project which is part of a collection of essays on Francophone women writers, the researcher analyzed three novels of Cohen focusing on the poetics of "fluidity" present in her writings, both on a semantic as well as a syntactic level. For this analysis, the researcher consulted Gaston Bachelard's, Gilbert Durand's and Luce Irigaray's theories on fluidity.

The project has been accepted for publication in an anthology entitled *Histoires d'eaux: Emergence d'une écriture dans les textes d'écrivaines francophones*, edited by Yolande Helm, to be published in the collection "Francophone Cultures and Literatures" of Peter Lang Publishing, Inc.

Marie Redonnet and Chantal Chawaf: Divergences and Convergences in Two "Engaged" Writings

Researcher: Assistant Professor Marianne Bosshard

The purpose of this project is to analyze the topics of identity, violence, isolation and non-communication in the writings of two contemporary French women authors whose oeuvres, at first sight, seem to have nothing in

common. Influenced by Kafka and Beckett, Redonnet's style and imaginary universe are diametrically opposed to Chawaf's regressive, introspective language of "reconciliation." In spite of these differences, however, the two writers address similar issues. The researcher will focus on the manner in which both writers deal with these issues.

The result of this study will be presented at the "International Colloquium on Contemporary Women's Literature in France, Québec and Acadia since 1985" to be held at Dalhousie University, Halifax, Canada, in September 1994.

The Black Poetry of Luis Palés Matos

Researcher: Associate Professor Maria E. Castro de Moux

This is a biographical and socio-historical study of Palés Matos' ideological development which ended in his proposal of a Puerto Rican national identity based on myth, folklore, race and ethnic values. His poems are examined, showing a progressive change from a detachment from socio-political events and a focus on European tastes, esoterism and lyrical poetry, to a growing interest in Puerto Rican problems and culture. Matos' poetry was initially devoted to the country folklore and gradually became an understanding of the relationship between race, culture and national identity. By finding in Afro-Antillean culture a ground for all Caribbean emerging nations, he correctly identified Puerto Rican culture as Afro-Hispanic, resulting in a public confrontation with Puerto Rican intellectual elites which valued only European art and culture.

Lukacs after Glasnost

Researcher: Professor Eva L. Corredor

This project was inspired by the recent ideological and political revolutions in Russia and Eastern Europe. It is based on a series of recorded interviews with nine eminent scholars, both in the United States and in various countries of Europe, who at the onset of their careers had been influenced by the theories of the Hungarian philosopher and literary critic, Gyorgy Lukacs, and since then have established themselves in their own right as major philosophers and theoreticians of the twentieth century. The results of this study will be published in book form.

A Slice of Russian Contemporary Lore: Strashilki and What They Tell Us

Researcher: Assistant Professor Clementine Creuziger

This article studies an often ignored aspect of folk lore, namely, child lore. Specifically, in this article the researcher analyzes Russian children's ghost stories as one might any oral narrative from both cultural and psychological perspectives. Ghost stories remain one of the few traditions that, despite the social and political upheavals in Russia over the past century, have remained constant. While some may change slightly from one telling to the next, new ones being added and old ones forgotten, the tradition of strashilki among children persists.

While many scholars in the social sciences have identified the study of children's culture and lore as important to the understanding of society as a whole, there has been a tendency to study children as simply acquiring culture from the adult world. This approach neglects the fact that children learn from each other, thereby maintaining and developing their own culture. Moreover, since children also contribute to adult culture, a study of child culture would contribute to our understanding of cultures as a whole.

Living the Taboos of Russia:
Orphans, Gangs, and Other Classics in the Making

Researcher: Assistant Professor Clementine Creuziger

Childhood, as is idealized by Russian parents, today can only be experienced by a privileged few. Leo Tolstoy's ideal, one that is often referred to in interviews when describing childhood, incompletely applies to any one family, and, moreover, completely passes by a whole sector of urban Russian society often ignored in statistics and social studies. This ignored sector of Russian society has little hope of ever experiencing childhood in traditional Russian terms. It includes the unwanted children: children with both major and minor disabilities, children born to alcoholic and/or abusive parents, children whose parents simply cannot cope, abandoned children without parents or any combination thereof. It includes approximately 69,000 children, a number that is on the rise and of which 4,000 includes children who are without parents. Such children are sent by the Russian government to any one of the variety of orphanages which has an available space.

The researcher analyzes the various options open to orphans, their life and the taboos that surround them daily. In particular, the researcher describes the various orphanages, street life, the teachers' and administrators' perspectives and the childrens' ideas on the subject through interviews, observation and linguistic analysis of pedagogical language used around children in the institutions. Because of the difficulties of the Russian orphanage system, which itself is jeopardized by the reigning social chaos in Russia, children are finding it less threatening to join street gangs and to fend for themselves, as adults. Only, these are not adults. These are children; they do not yet have the abilities that adults have to make their way in society. They can only survive in one profession: crime. In gangs, the children feel needed and loved by their peers. There is a closeness there, greater than any closeness experienced in institutions, and perhaps similar to what they envision a family to be like.

The study has been selected for presentation at the American Anthropological Association's annual meeting in November.

Religion and Spirituality in Russia

Researcher: Assistant Professor Clementine Creuziger

Now that Russian adults are once again openly participating in previously shunned religious practices and beliefs, the role of religious socialization is significant to those scholars interested in Russian culture and society. The issue evokes questions in anthropology concerning religious integration in family traditions and the structure of the official school system. It also addresses more basic questions about beliefs and values of future generations of Russians. With a renewed interest in religion and religious socialization, the character of Russian socialization is bound to change, significantly affecting not only the homes, but the schools and work

place of Russia's future. Over the summer of 1994, the researcher plans to complete this paper focusing on the role of spirituality in socialization of Russia's children. Next, the researcher will study the role of death rituals and symbolism in the ever changing political and social atmosphere.

Part of the results of this study were presented at the American Anthropological Associations's session entitled "Spirituality, Religious Identity and the State in the Cultural Aftermath of the Soviet Union" held in Washington, D.C. in November of 1993.

A Different France: Documents from the Minority
Cultures of France

Researcher: Associate Professor Audrey Gaquin

A Different France is an anthology of documents from seven regions of France whose inhabitants may be said to represent two cultures, that of the French nation, and that of the local culture, which is expressed in a language other than French, and which has a history and traditions other than those of mainstream France. These seven

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regions, known in France as "minorités installés," include Alsace, the French Basque country, Brittany, North Catalonia, Western Flanders (Westhoek), Corsica and Occitania. One section of the anthology is devoted to each of the seven minorities, and each section includes a historical introduction, an interview with a minority leader, articles on political and economic issues concerning the region in question, sample lessons in the minority language with translation into French, and information about customs, traditions and folk art in the region.

The "minorités installées" have benefitted to some extent from recent legislation that has allowed greater regional autonomy in all of France and has removed some of the limits on freedom of expression of minorities; limits that had been in place in some cases since the Revolution of 1789. Autonomist groups garner varying degrees of support in the various regions, and their own degree of militancy varies, but their fundamental strength is reflected in the election of Max Simeoni, a Corsican autonomist, to the European Parliament, the inclusion of the Catalan language among the official languages of the European Parliament, and the proliferation of ties among European regions that is beginning to result from the abolition of trade barriers at the end of 1992. At present, France has not yet signed the Charter of Rights of Minorities of the Council of Europe, which would guarantee the rights of these minorities to media time, and this refusal to sign has intensified the sense of urgency of those minority members who wish to assure the survival of their language and culture.

In the United States, it is difficult to obtain even basic information about these minorities. *A Different France* has been compiled in response to a growing need among Amercians to recognize and understand this other side of French culture by making available to students, teachers and scholars primary source materials and background information on the seven minorities.

Elements of Theoretical Linguistics in Priscian's *Institutiones*

Researcher: Associate Professor Audrey Gaquin

An examination of Priscian's *Institutiones*, the last great Roman grammatical treatise, shows that this work made available to Priscian's medieval successors certain fundamental theories on the nature of language. The theoretical material is found in the presentations of the different levels of language and the definitions of the noun and verb; these discussions stress the role of the communication context in governing language production, and affirm the predominance of the semantic component of language in determining linguistic paradigms and practices. Priscian defines the semantic component as a set of semantic wholes, which are broken down into their component parts and matched with linguistic forms in order to produce language. This monograph, to be published by John Benjamins in their *Studies in the History of Linguistics* series, is a collection of case studies of the development of Priscian's theory of semantic wholes in his theoretical discussions.

Marco Antonio de la Parra and the New Chilean Theatre

Researcher: Associate Professor Elsa M. Gilmore

Chilean theatre has flourished in the twentieth century. It was particularly fruitful in the sixties and early seventies, when members of the "Generation of 1950" produced a number of plays which have achieved international acclaim. In recent years, however, the Chilean theatre has lacked new luminaries. This void is now being filled by a 38 year-old post-modern satirist by the name of Marco Antonio de la Parra.

De la Parra appeared on the Chilean stage in the waning years of the Pinochet regime, as the nation was preparing to reenter a democratic historical course. Parra's best known plays, *The Raw, the Cooked, and the Rotten* (1985), *Tango-Killer* (1985), and *Our daily Secret Obscenity* (1987), have caused an artistic and political sensation in Santiago, and have already been performed to public and critical acclaim throughout the continent and abroad. One of them, *Tango-Killer*, was selected for the 1988 Kennedy Center Gala Festival in Washington, D.C.

The researcher has reviewed de la Parra's dramatic production and appropriate criticism and has presented conference papers on each of the plays mentioned above. In addition, the researcher has commenced work on de la Parra's most recent plays which espouse a post-modern

aesthetics and explore the definitions of literary genres (tragedy, comedy, comic strip). Two different articles on this subject were presented at international conferences during the summer of 1993. A lengthy research article focusing on the dramatic structure of *Our Daily Secret* *Obscenity* has been accepted for publication by *Latin American Theatre Review*. A second article, also to be published in a forthcoming de la Parra anthology (in English translation) is at press as of this writing.

"What do Women Want?" Gabriela Roepke's *The White Butterfly*

Researcher: Associate Professor Elsa M. Gilmore

This project, scheduled for presentation in October at the "A Stage of Their Own" conference on Hispanic Women in the Theatre (University of Cincinnati) investigates character dynamics in the light of recent critical and psychological theory. The study analyzes the play's views on various forms of conflict resolution. With this study, the researcher expands her field of research into Chilean theatre.

Textual Deformity in Matias Montes Huidobro's *Eyes to be Blind With*

Researcher: Associate Professor Elsa M. Gilmore

This paper, scheduled for presentation at the American Association of Teachers of Spanish and Portuguese conference, Philadelphia, in August of 1994, deals with the linguistic and perceptual deformities which emanate from the text. The researcher argues that the text's unconventional characteristics can be explained in terms of ritual practices associated with "underground" religions long practiced in several Caribbean nations.

The Phantom of the Opera: Illusion's Deadly Spell

Researcher: Assistant Professor Elizabeth M. Knutson

In Gaston Leroux's novel, *Le Fantôme de l'Opéra*, the fantastic tale of the phantom is framed by an investigative inquiry which the narrator-historian undertakes in the interest of providing a rational explanation for seemingly supernatural events. The discourse of the narrator is particularly manifest in such metanarrative structures as chapter titles, footnotes, preface and epilogue. The interest of the text lies in the pull between this discourse, on the one hand, and the narrative itself, which in fact delays the quest for meaning, prolonging the enigma of the phantom and celebrating the pleasure of the horror story. The power of illusion proves to be the pervasive theme and dominant discourse of the novel. The discourse and thematic resonance of the horror tale also represent a subversion of the dominant cultural order. This study analyzes the play between rationalism and the fantastic in Leroux's novel, making reference to the theoretical analyses of Tzvetan Todorov and Ulrich Doring, which focus on the pragmatic and anti-cultural dimensions of fantastic fiction, respectively.

Perspectives on the Use of the First Language (L1) in the Foreign Language Classroom

Researchers: Assistant Professor Elizabeth M. Knutson and Associate Professor Penelope Bledsoe

This study is based on a survey of views of instructors and students on the use of the L1 (English) and L2 in the intermediate level foreign language classroom. The study begins with an overview of the issue of English versus

target language usage in foreign language pedagogy, beginning with audio-lingual methodology and continuing on through the proficiency-oriented and communicative approaches which dominate current thinking. The results of the survey are analyzed as a sampling of opinion and concerns with respect to L1 and L2 use on the part of both students and instructors in intermediate level foreign language courses.

Russian History and Civilization Reader: XIXth-XXth Centuries

Researcher: Associate Professor Ludmila Pruner

This project is an original text in Russian with reading exercises for the development of reading strategies at Intermediate and Advanced levels. Work is conducted in collaboration with Alexander Osipovich, Pittsburgh University, and Dr. Nikolai Slobin, History Department, Moscow State University.

Juan de Mena's *Laberinto de Fortuna*: A Critical Transcription and Concordance of ESP.MS 229 of the Bibliothèque Nationale, Paris

Researcher: Professor Gladys Rivera-La Scala

This work will be published by the Hispanic Seminary of Medieval Studies, University of Wisconsin-Madison, as part of their National Endowment for the Humanities-sponsored project. The lexicon from the concordance will be included in the first *Dictionary of Old Spanish*, the first volumes of which are scheduled for dissemination in the early 1990's. This thirty-year project, begun in the late 50's by Prof. Lloyd Kasten, has enjoyed yearly support from the National Endowment for the Humanities for over 10 years and has benefitted from the expertise and work of at least two generations of scholars from the national and international communities.

Juan de Mena's *Coplas de Los Siete Pecados Mortales*: Second and Third Continuations: A Critical Edition and Study

Researcher: Professor Gladys Rivera-La Scala

This book includes the first critical edition of the Second and Third Continuations of the *Coplas de Los Siete Pecados Mortales*, left unfinished at Juan de Mena's death, and an intertextual analysis of the main poem and its three continuations. The first chapter contains a comparative study of the four works based on themes, imagery, meter, and rhyme. In the second chapter the author gives detailed, firsthand descriptions of the manuscripts and 16th century printings used in establishing the base text and discusses the interrelationships that exist between the many versions of the works. A corrected version of the continuations in modern script follows. Editorial, literary, and linguistic notes comprise the next section which ends with a glossary of medieval Spanish terms and one of proper names. Included in this volume is an extensive bibliography of primary and secondary source materials on Spanish and European 15th-century didactic poetry. It will be completed by August, 1994, and sent to the publisher to be published in *Studia Humanistica*.

Adjuvancy and Opposition: A Study of Supporting Roles in Pedro Calderon de la Barca (1600-1681)

Researcher: Professor Sharon Dahlgren Voros

This book-length study combines the methodology of semiotics with archival research on Pedro Calderon's secular and religious drama. While supporting or secondary roles are often overlooked in drama studies, they provide keys for interpreting the playtext, since they complement and comment on the action of the main

characters. Adjuvancy and opposition, terms from A.J. Greimas's semiotic model, imply actanticial functions of characters of subordinate social rank, and hence often marginalized figures of Spanish society. The researcher presented two papers in connection with gender issues that evolve from the study of feminine characterization and stage practice. The first paper discusses several women dramatists of the seventeenth century: Ana Caro, Maria de Zayas, Leonor de la Cueva, and the Mexican nun, Sor Juana Ines de la Cruz, and their depiction of feminine intelligence or wit on the stage. While male-authored texts, as in Mira de

Amescua, Lope de Vega, and Calderon, frequently use terms for *ingenio* or wit as praise for feminine intelligence, women dramatists are just as often reticent on the topic. Instead, they employ a different, more specific register of semantically related terms, such as *discrecion,* a combination of wit and genius according to Jesuit treatises on the subject. If one considers St. Teresa of Avila as a model for feminine discourse, the silence regarding the problematic term *ingenio* readily becomes apparent. While the Spanish saint is willing to attribute intelligence to others, especially men, she is reluctant to speak of her own mental agility, although male contemporaries recognized and expounded on her wittiness. It is not until one reaches the end of the seventeenth century in Mexico, with Sor Juana, that we see a reemergence of wit as a critical term for feminine consciousness and expertise.

Publications

CASTRO DE MOUX, Maria E., Associate Professor, "Esoterismo y Cabala en la poesia temprana de Luis Palés Matos," LA CHISPA '93 Selected Proceedings, Tulane University, New Orleans, Louisiana, (1993), 163-173.

Puerto Rican poet Luis Palés Matos' early period is examined showing Masonic and Judaic mystic influences. Beliefs and symbols such as reincarnation, the tree of life, the "third" eye and other esoteric concepts appear in his poetry within the main framework of Manichean notions of light and shadow. This ideology influenced his last cycle, the lyrical poems to "Fili-Melé."

CASTRO DE MOUX, Maria E., Associate Professor, "Tipos de discurso teatral en el entremés de *Los negros* de Simon Aguado," *Bulletin of the Comediantes*, 45-1 (1993), 53-66.

The conflict between slave owners and black slaves is studied in Aguado's "Entremés de los negros" (1602) using Juan Villegas' model of dramatic discourse linking speech and social status. Black characters use Catholic theological, philosophical and legal arguments, derived from Erasmus of Rotterdam and other humanistic currents, to further their rights and to subvert an unjust social order. Their discourse is silenced at the end. The play's value for modern times lies in its being a social document of Baroque Spain and in the surprisingly modern dramatic discourse of marginal groups defending their rights to freedom in Imperial Spain.

CORREDOR, Eva L., Professor, "The Ambiguity of the Status of Art in Modern Society," a review essay, *New German Critique*, (fall 1993), 60, 171-179.

This essay addresses some of the assumptions about the production, reception and status of art in society made by Peter and Christa Buerger in *Theory of Avant Garde, The Institutions of Art,* and the *Decline of Modernism.* Institutionalized functional determinants of literature are responsible for basic norms in society that either validate or denigrate particular literary practice. Artistic opposition to such determinants led in the nineteenth century, more so in Germany than in France, to the development of a certain autonomy of art. While this withdrawal of art from real-life praxis has been seen as romantic nostalgia and a desire for artistic freedom, it would be more appropriate to examine its development within a socio-historical context. In its dialectic function, modernist art has given form to its oppositional status in society by movements such as impressionism, the avant-garde, and surrealism, before presenting us with the most recent, seemingly institutionalized but critically, still ambiguous aesthetics of the postmodern. Since art usually precedes its conceptualization, the contemporary critic can practice "immersion in the matter at hand," as Adorno recommends, but the theoretician must remain humble. The status of postmodernist art still seems to escape categorization.

KNUTSON, Elizabeth M., Assistant Professor, "Teaching Whole Texts: Literature and Foreign Language Reading Instruction," *The French Review* 67,1 (1993), 12-26.

While reading research has clearly begun to inform elementary and intermediate levels of instruction, its influence is less apparent at advanced levels, particularly in the teaching of literature. In third year undergraduate courses, whole texts such as novels or plays are commonly introduced; however, at this stage the instructional focus often shifts abruptly from reader to text, and reading proficiency per se is no longer directly addressed. This article proposes a generic approach to the teaching of literary works, relating instructional practice to research on reading comprehension and addressing the issues of text-reader interaction, readability, background knowledge, and fluency.

KNUTSON, Elizabeth M., Assistant Professor, "The Social Context of Classroom Reading: Learning through Talk," *Perspectives in Foreign Language Teaching*, VII (1993), 87-98.

Two concepts underlie the argument made in this article for an exploration of collaborative reading in the classroom: literacy, defined as a situated competence rather than a decontextualized set of cognitive and linguistic skills; and collaborative learning, which involves students working in groups to perform a task or achieve a common learning goal. The article explores the difference between individual and group encounters with text, and the communicative context in which reading and interpretation take place in the foreign language classroom. Finally, it proposes a classroom approach to reading which promotes the negotiation of textual meaning within groups, shifting the immediate communicative context away from individual performance and evaluation to group sharing of information.

VOROS, Sharon Dahlgren, Professor "Calderon's Writing Women and Women Writers: The Subversion of theExempla," *Looking at the Comedia in the Year of the Quincentennial: Proceedings of the 1992 Symposium on Golden Age Drama* at the University of Texas, El Paso, March 18-21, , eds. Barbara Mujica, Georgetown University, and Sharon D. Voros, United States Naval Academy, University Press of America, (1993), 121-132.

This study proposes a model for a theoretical middle ground upon which to evaluate male and female-authored texts in the Spanish Golden Age. Calderon and women dramatists of his era, Maria de Zayas, Ana Caro, and Leonor de la Cueva, all explore the *exempla* tradition of biographies of women's lives, especially the *De claris mulieribus* (On Illustrious Women), Boccaccio's Latin treatise. These *exempla* not only subvert notions of gender but also can be subverted. Cueva's feminine protagonist, Armesinda, succeeds in saving her honor when she invokes the famous *exempla* of women who have stood firm in their convictions, a significant socio-political position in an age that considered women inferior, but not incapable of achievement. Even in Calderon there is a recognition of the problematics of femininity, as these contextualizations of the *exempla*, like the Queen of Sheba, the Great Zenobia, show.

VOROS, Sharon Dahlgren, Professor, "Thomas Kyd, Pedro Calderón, y la semiótica de la representación femenina," in *Vidas paralelas: el teatro espanol y el teatro isabelino de 1580 a 1680*, ed. Anita K. Stoll, Tamesis Books Limited: London and Madrid, (1993), 77-88.

Presented at the Annual Classical Theater Festivas Symposium in Almagro, Spain, in 1991, this article compares *The Spanish Tragedy* of Thomas Kyd to the revenge play, *De un castigo, tres venganzas* of Pedro Calderón, as concerns feminine performance codes and their influence on stage action. Using semiotics, the researcher sets forth a comparative semiotic model with which to analyze the dramatic effect of gestural codes and symbolic stage properties of the two central feminine personages, Bel-Imperia in Kyd and Flor in Calderón. The researcher draws on the critical notions of signs articulated by the American semiotician, Charles S. Peirce, and the French semanticist/semiotician, Algirdas J. Greimas. Since feminine beauty symbolizes moral truth in both plays, micro- and macro-semiotic levels in sign systems show the depth of interrelationships between the personal and political levels. Feminine beauty thus provides not only an aesthetics for theater but also an ethics for the art of good government.

Presentations

BOSSHARD, Marianne, Assistant Professor, "Chantal Chawaf: Le mythème de la femme comme initiatrice à la spiritualisation de la chair," Colloque International sur les mythes dans la littérature contemporaine d'expression française, Université d'Ottawa, Ottawa, Canada, 24-26 March 1994.

CASTRO DE MOUX, Maria E., Associate Professor, "La gitana picara y el criado flematico: Sobre el *Entremés de Pedro Hernandez y el Corregidor,*" Fourtheenth Golden Age Theater Symposium, University of Texas, El Paso, Texas, 10 March 1994.

CORREDOR, Eva L., Professor, "Marxism and the Novel: The Seduction of Realism," International Conference on "The French Novel from Lafayette to Desvignes" to Celebrate the Centenary of the Completion of Emile Zola's *Les Rougon-Macquart,* 1893-1993, University of Tennessee, Knoxville, Tennessee, 3-7 November 1993.

CREUZIGER, Clementine, Assistant Professor, "Spiritual Socialization of Russian Children in Homes and at School," Conference of the American Anthropological Association, Washington, D.C., 16 November 1993.

CREUZIGER, Clementine, Assistant Professor, "Coming of Age in Contemporary Russia," Social Science Research Council Summer Workshop in Post-Soviet Sociology and Anthropology, Stanford University, Palo Alto, California, 27 June-3 July, 1993.

FLETCHER, William H., Associate Professor, "Integrating Multimedia Into the Curriculum: Expectations and Realities," Focus Group on Technology-Based Training, FBI Academy, Quantico, Virginia, 22-25 February 1994.

GAQUIN, Audrey, Associate Professor, "Le Moi fragmenté et réintégré chez les poètes bretons contemporains," Annual Congress of the Conseil International d'Etudes Francophones, Quebec City, Quebec, Canada, 14 April 1994.

GILMORE, Elsa M., Associate Professor, "Genre Distortions: Novel, Tragedy and Comic Strip in Two

Plays by Marco Antonio de la Parra," International Semiotics Conference, University of Veracruz, Jalapa, Veracruz, Mexico, 8 July 1993.

GILMORE, Elsa M., Associate Professor, "Post-Modernist Elements in de la Parra's *King Kong Palace,*" First International Theatre Conference, University of Tennessee/The City of Puebla, Puebla, Mexico, 12 July 1993.

GILMORE, Elsa, M., Associate Professor, "The Rise, Fall...and Rise (!) of Carlos Gardel," Conference on Contexts and Crosscurrents, The Pennsylvania State University, State College, Pennsylvania, 15 April 1994.

KNUTSON, Elizabeth M., Assistant Professor, "The Social Context of Classroom Reading," Youngstown Annual Conference on the Teaching of Foreign Languages and Literatures, Youngstown State University, Youngstown, Ohio, 29 October 1993.

KNUTSON, Elizabeth M., Assistant Professor, "Literature and the Return to Reading," Modern Language Association Annual Convention, Toronto, Canada, 29 December 1993.

PRUNER, Ludmila A., Associate Professor, "Cultural Ecology and Post-Modernity in 'Other' Cinemas," American Association for the Advancement of Slavic Studies, Honolulu, Hawaii, November 1993.

PRUNER, Ludmila A., Associate Professor, "New Tendencies in Postmodernist Russian-Speaking Cinema," American Association of Teachers of Slavic and East European Languages, Toronto, Canada, December 1993.

VOROS, Sharon Dahlgren., Professor, "Seventeenth-century Women Dramatists and the Concept of *Ingenio* [Wit]," Fourtheenth Annual International Golde Age Drama Symposium, University of Texas, El Paso, 9 March 1994.

VOROS, Sharon Dhalgren, Professor, "Staging Calderon's *El escondido y la tapada* [The Hidden Lover and the Veiled Lady]," Forty-seventh Annual Kentucky Foreign Language Conference, Lexington, Kentucky, 23 April, 1994.

Political Science

Professor John A. Fitzgerald
Chair

For the past year, the world has remained in political flux, in both the domestic and international political arenas. The Department of Political Science has actively sought to understand and explain the increasingly complicated political landscape of the world through numerous diverse and challenging research projects involving not only faculty but midshipmen as well. This vital task provides midshipmen with the skills necessary to fully understand and explain the political environment that surrounds the policies and activities of the Navy.

Research projects have been conducted on such such varied subjects as the economic development of Poland, the future of NATO, congressional coalitions, and the intelligence requirements of a post Cold War world. Sources of funding for this extensive research program included the Naval Academy Research Council, the National Science Foundation, and the United States Institute for Peace.

Not surprisingly, the research activities of members of the Department of Political Science have resulted in an impressive array of publications, including books, chapters of books, and scholarly articles. This year, Professor Stephen Frantzich has even led the department onto the information superhighway by developing a CD-ROM version of his American government text. The faculty have been especially active in presenting the results of their research in scholarly and professionalforums throughout the United States and in many European countries.

Midshipmen have continued to play a vital role in the department's research program. Several have completed independent research and four have received advanced education awards through the Voluntary Graduate Education Program.

Sponsored Research

American Council on Education National Norms Study of College Students

Researcher: Assistant Professor Eloise F. Malone
Sponsor: Naval Academy Research Council (OMN)

This is an ongoing study of American college students' attitudes and behaviors begun in the late 1960s. The data sets have been recomputed as SPSSX system files and moved to the SUN system in computer services. Professors Cochran and Malone administered the survey during the summer of 1993 and are compiling and summarizing the data. They plan to extend the analysis of ACE survey results by comparing them with the Defining Issues Test" (DIT).

The study offers the opportunity to compare midshipmen attitudes and characteristics with national norms of college freshmen. No particular investigation of a military educational context and CIRP responses appears in the literature. Such comparisons provide valuable conclusions to students of political socialization patterns, educational trends, and leadership studies.

Early Warning of Communal Conflicts and Humanitarian Crises

Researcher: Associate Professor Barbara Harff
Sponsor: United States Institute of Peace

Funding for this research came from a $50,000 grant from the U.S. Institute for Peace and administered by the University of Maryland. The goal of this research is to establish a set of factors that will serve as a type of early warning system for potential communal conflicts and humanitarian crises. This study is not merely of academic concern, as national strategic planners will have a vested interest in knowing the potential "hot spots" of the future.

Estimating Causal Models of Communal Conflict and Coercive Regime Responses Using Group-Level Data

Researcher: Associate Professor Barbara Harff
Sponsor: National Science Foundation

The researcher was a co-recipient of a $125,000 grant from the National Science Foundation. The study will attempt to use group-level data to establish causal models of communal conflict and coercive regime responses. These models, once established, will aid social scientists in attempting to predict trouble spots and areas of future conflict.

Independent Research

The Inevitable Slide into Coercive Peacemaking: The United States' Role in Peacekeeping in the New World Order

Researcher: Associate Professor Wille Curtis

Given the changing nature of conflict in the new world order, traditional peacekeeping methods are ill-equipped to cope with the brutal ethnic, religious, social, cultural, linguistic, intrastate, and communal strife confronting the international community today. The public's perception of peacekeeping has changed significantly and new terms such as peacemaking, peace-enforcement, and post-conflict peace-building best describe the expanding role of the U.N.. The question for U.S. defense planners is what role should the U.S. military play in support of U.N. operations. This article argues that while the traditional role of peacekeeping is still a legitimate function for the U.S. military in the Post-Cold War era, a thorough assessment of the potential problems and cost should be undertaken before commitment is made to these expanded operations. A large-scale commitment of U.S. forces to the expanded U.N. peacemaking, peace-enforcement, and peace-building role without a clearly defined national strategy will lead to an inevitable slide into coercive peacemaking.

Maneuvering in the Gray Zone: The Gap between Traditional Peacekeeping and Warfighting: Peacemaking, Peace-Enforcement and Post-Conflict Peace-Building

Researcher: Associate Professor Wille Curtis

This article identifies potential dangers of operating in gray zone peacemaking, peace-enforcement, and post- conflict peace-building by arguing that with the exception of traditional peacekeeping, gray zone operations without

a clearly articulated national strategy are questionable missions at best, and that the Clinton Administration will not be able to develop the political and military objectives that will permit military leaders to structure the forces necessary to engage successfully in gray zone operations.

Analysis of the Mainland Chinese Leadership

Researcher: Professor Rodney G. Tomlinson

The Chinese Leadership project is now in its 18th year. With the addition of 40 new biographies and completion of a thorough review, the information is again being reviewed. The trend toward liberalization noted in 1991 ceased with the removal of some progressives in 1992 but major changes appeared in 1993 with significant liberalization in the economic realm, which is reflecting the political leadership. Some younger conservative appear to be compromising with economic realities, thereby heralding a subtler move toward greater liberalization. The Peoples' Liberation Army (PLA) displays a remarkable spectrum of activities, ranging from efforts to modernize arms to branching into non-military activities. Depending on the military district, PLA commanders can be found diversifying PLA factories to produce consumer goods as sources of revenue (and personal enrichment). This trend looks to continue with the recent concession by the central government to permit another year of literally unbridled economic expansion.

Editing the Letters of Charles H. Fowler

Researcher: Professor Rodney G. Tomlinson

This project involves editing 110 letters, about 1100 pages of hand script. To date, fifty letters have been completed, creating about 125 pages of types manuscript and about 300 pages of book manuscript.

Charles H. Fowler served in Theodore Roosevelt's navy from 1906 to 1910. Joining in 1906 as a seaman recruit, young Charles's skill with the pen and word led to early assignment as a ship's log writer. Assigned to the US Asiatic Squadron at Subic Bay, PI, Fowler's bright mind and attention to detail attracted his superiors' attention leading to his participation in many interesting exercises and activities of the day. Fowler chronicles life in the Orient through a collection of eighty letters to his sister, along with over 200 photos. Fowler provides first hand looks at life 'tween' decks in an articulate and engaging style rarely found among enlisted men.

The Structure of International Events:
Testing a Theoretic Model of World Political Behavior

Researcher: Professor Rodney G. Tomlinson

This research is ongoing and focuses primarily on maintaining the World Events/Interaction Survey data files and then testing the behavioral model with the new data. During the summer of 1993 and then Christmas, 1993, eighteen months of additional data (7/92-12/93) were collected. This continuing effort led to a forthcoming article in Ted Gurr and Barbara Harff's book on genocide.

As reported last year, this research has gained added impetus with the advent of the Clinton administration, where new emphasis has been added to crisis early warning and increased intelligence funding. Hence, the rules and norms that circumscribe international political behavior become increasingly important as devices for detecting impending difficult situations. The vast majority of national leaders conform to customs of diplomatic practice. They tend to ascribe to similar perceptual constructs as to the meaning and impact of certain actions. This case studies and analysis effort identified patterns of conduct indicative of stable, problem solving relationships and found evidence to characterize non-problem solving behavior. The presence or absence of the patterns provide clues to the general outcome of a situational issue. These findings independently corroborate work of other scholars, thereby lending credence to some general theories of conflict.

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Research Course Projects

Congressional Coalition Building on the Budget

Researcher: Midshipman 1/C Kasey Ingram, USN
Adviser: Professor Stephen Frantzich

Using the theories of William Riker and others on coalition building in collective decision-making bodies, this paper looks at the fit between theory and reality on budget votes in Congress. The research combines empirical analysis and an extensive set of interviews to outline the coalition process.

The Development of Nations in Central Asia: Kazakhstan

Researcher: Midshipman 1/C Grant Goodrich, USN
Adviser: Professor Arthur R. Rachwald

This work centered around examining the emergence of Central Asian republics, particularly Kazakhstan, from the cloak of Communism into today's market economy. The study focused on the economic and political aspects of change and development in that nation, especially those developments resulting from the exploitation and sale of natural resources.

The study was further altered to encompass more detailed aspects of methodology and model systems. In particular, Midshipman Goodrich worked with the conceptual model of development of nations offered by Peter Merkl, and John Reshetar's models of Soviet polity to enhance the methodological aspects of the study.

The Future of NATO

Researcher: Midshipman 1/C Paul Prokopovich, USN
Adviser: Professor Arthur Rachwald

This political science honors project was undertaken in the fall of 1993 during the first class year of the midshipman researcher, Paul Prokopovich, Class of 1994 and was finished at the end of his first class year. The original topic related the future of NATO and the role the U.S. would play in the alliance. In an effort to limit the scope of the study, Midshipman Prokopovich focused on the study of alliance theory and how it could be applied to the future of the North Atlantic Alliance. Research included a focus on alliance theory, an examination of historical implications, and a discussion of recent summits in which the allies redefined the roles and missions of NATO.

During the year long study, Midshipman Prokopovich obtained information from many sources. A large portion of his research was done during a two month internship at Supreme Headquarters Allied Powers Europe (SHAPE) in Mons, Belgium. There he collected information from various sources, including interviews with foreign officers, unclassified documents, and speeches from numerous Alliance leaders, including SACEUR and NATO's Secretary General. During the academic year, Midshipman Prokopovich continued his research by attending several seminars in the Washington, D.C. area. Relevant material was also obtained from libraries in the region as well as a NATO database on the Internet computer network. Combining this research allowed Midshipman Prokopovich an opportunity to defend his hypothesis on the future of the North Atlantic Alliance.

Intelligence Requirements in the Post Cold War

Researcher: Midshipman 1/C Patrick Hooper, USN
Adviser: Professor Charles L. Cochran

This project examines the intelligence requirements in the period after the Cold War based upon the peculiar nature of the threat. After the Cold War, the threat of surprise attack from the Soviet Union has been substantially reduced. Without the discipline of the Cold War, the threat appears to be less strategic in nature and more concerned with political rivalries in the former Soviet empire and in Third World economic problems. The threat of terrorism and civil wars is greater. A reorienting of intelligence assets to increase focus on economic development (and collapse), income distribution and similar issues will provide greater insight into issues of stability and violence.

Privatization of Poland

Researcher: Midshipman 1/C Jeffrey D. Clark, USN
Adviser: Professor Arthur R. Rachwald

Midshipman Clark's original topic was *The Reform and Revitalization of Central Europe by Government and Business: Privatization in Eastern Europe: Hungary, Poland, and the Czech Republic,* but limited it to the study of Poland's privatization to provide a more succinct scope of study. The primary focus of the study was to examine the privatization process: its origins, implementation, and resulting effects on the country, economy, and people of Poland.

Over the course of the semester, Midshipman Clark researched the project from varied angles. His initial basis of information was attained from a Cornell University study after a week-long seminar of American business leaders on the economic evolution of Eastern Europe. The most imaginative and fruitful of Midshipman Clark's research came about late in the semester as he was able to schedule personal interviews with several international delegates to the United Nations. During his trip to New York, he interviewed Ambassador Peter Osvold of Sweden, Mr. Bertocelli of the Italian Embassy, a Polish dignitary within the United Nations, and the ambassador to the U.N. from the United Kingdom. Gathering the viewpoints of these prominent leaders gave Midshipman Clark a wide variety of opinions concerning the progress and future of Poland's economic development.

Publications

COCHRAN, Charles L., Professor, and Eloise F. MALONE, Assistant Professor, co-authors, *Public Policy Choices,* New York: McGraw Hill, (1994).

This text stresses the economic basis of public policy, discussing the difference between public and private goods, the problems of scarcity and rational self-interest. The authors examine public policy using a public choice model which emphasizes economic considerations. They also stress the ethical implications of choice in public policy.

DIPAOLA, Joe, LT, USN, Instructor, "Sea Hawk at War," *Defense Helicopter,* (December 1993- February 1994), 16-18.

This article describes the role of the SH-60B Sea Hawk during the Persian Gulf War. Featured is a description of the various capabilities of the LAMPS Mk III system. The Sea Hawk was a valuable multirole platform during Operation Desert Storm. Pilots and air crews were fulfilling vital roles of reconnaissance, mine clearance, antiship surveillance and targeting, and medical evacuation. The numerous capabilities of the Sea Hawk permitted other platforms to complete their missions more effectively. Joint operations with Army OH-58 Kiowa Warriors were perfect examples of using two platforms' assets to achieve mission completion. The Sea Hawk's radar, ESM and FLIR allowed the Army helos to effectively place weapons on target. New SH-60B versions will be better armed for future regional conflicts.

FRANTZICH, Stephen, Professor, co-author, *American Government: The Political Game*, Brown and Benchmark, (1994).

A comprehensive undergraduate textbook designed around the game analogy and emphasizing the role of technology in modern politics.

FRANTZICH, Stephen, Professor, co-author, *American Government: The Political Game--Instructor's Guide*, Brown and Benchmark, (1994).

FRANTZICH, Stephen, Professor, co-author, *American Government: The Political Game-- Student Guide*, Brown and Benchmark, (1994).

FRANTZICH, Stephen, Professor, *Congressional Database Analysis Package*, National Planning and Consulting Corporation, (1994).

A book of student exercises to accompany the Congressional Database.

FRANTZICH, Stephen, Professor, "He Who Pays the Piper: Party Campaign Contributions and Party Line Voting in Congress," edited by John Green, *Politics, Professionalism, and Power*, Washington, D.C.: University Press of America, (1994), 265-282.

An empirical analysis of the contribution strategies of the national party campaign organizations with particular emphasis on the utility of such contributions for party cohesion.

HARFF, Barbara, Associate Professor, "An Early Warning System is Needed," *Institute for Genocide Studies Newsletter*, #11, (Fall 1993), 206.

The article proposes answers to numerous questions, such as: What should be the preconditions for creating and recognizing new states and retracting (or suspending) recognition? To what extent should national and international aid agencies take into account violations of basic human rights when considering denying aid? Can the norm for protecting human rights be strengthened to be as imperative as the norm against aggression or the norm for self-determination within the U.N.? Under what circumstances should the U.S. or any other state, coalitions of states, and organizations use force for humanitarian intervention to protect the lives of peoples at risk of genocide and to prevent gross and massive abuse of human rights?

HARFF, Barbara, Associate Professor, "Bosnia and Somalia: The Strategic, Legal and Moral Aspects of Humanitarian Intervention," *Report from the Institute for Philosophy and Public Policy*, College Park: University of Maryland Press, (December 1992), 1-7.

The article delineates the international community's range of options for responding to emerging communal conflicts and humanitarian crises. The choices are not restricted to passivity on the one hand and total war on the other. Unilateral intervention should not be used unless all collective remedies are exhausted. The intervener must prove necessity and proportionality; military intervention has to be shown to be imperative and should remain the last resort.

HARFF, Barbara, Associate Professor, co-author, *Ethnic Conflict in World Politics*, College Park: University of Maryland Press, (1994), 206.

From Africa's post-colonial rebellions in the 1960s and 1970s to the anti-immigrant violence in Europe in the 1990s, *Ethnic Conflict in World Politics* surveys the historical, geographic, and cultural diversity of ethnopolitical conflict. Using an analytical model to elucidate four well-chosen case studies -- the Kurds, the Miskitos, the Chinese in Malaysia, and the Turks in Germany -- the authors give students tools for analyzing emerging conflicts based on the demands of nationalists, indigenous peoples, and immigrant minorities throughout the world. The international community is challenged to respond more constructively to these conflicts than it has in divided Yugoslavia.

HARFF, Barbara, Associate Professor, "Minorities, Rebellion, and Repression in the Middle East," in Ted R. Gurr, *Minorities at Risk: A Global View of Ethnopolitical Conflict*, Washington: United States Institute of Peace Press, (June 1993), 217-251.

Comparative evidence shows that minorities in the Middle East experience greater political inequalities than groups in other regions. Problems are most severe in the Core of the Arab world; there is less inequality and greater accommodation among communal groups in North Africa and Pakistan. In seven case studies, the chapter highlights sources of communal inequalities, conflict and repression. The chapter traces the political mobilization of groups, examines their claims and patterns of discrimination, and assesses regimes' responses to communal protests and rebellions. The following groups are analyzed: the Palestinians, a stateless people with a strong sense of national identity;

the Kurds in Iraq, who are representative of ethnically distinct groups that are dispersed across international boundaries; the Berbers of Morocco, a transnational people, whose aspirations are mainly cultural and economic; Arabs in Israel, who identify with their Palestinian brethren in the West Bank and Gaza, but focus their attention on improving their status within Israel; the Shi'i in Lebanon and Palestinian immigrants, both have been involved in the civil war, but against different antagonists; and the Baha'is, a religious minority repressed by the theocratic regime in Iran.

HARFF, Barbara, Associate Professor, "The Tragedy of Cambodian History: Politics, War, and Revolution Since 1945," in *Annals of the American Academy of Political & Social Science*, 526, (March 1993), 205-206.

This article is a review of the book *The Tragedy of Cambodian History: Politics, War, and Revolution Since 1945.*

LAMB, Karl, Professor, *Reasonable Disagreement: Two Senators and the American Political Development.*

This parallel political biography of Senator Paul Sarbanes (D -MD) and Senator Richard Lugar (R - IN) revives a concept as old as Plutarch to illuminate the U.S. Senate in a new way.

MACHADO, Priscilla, Assistant Professor, "The Design and Redesign of the Rule of Exclusion: Search and Seizure Law in the United States and Canada," *The Canadian Review of American Studies*, (Fall, 1993), 1-39.

Balancing the rights of accused with government's concern for security and the rights of the whole is a timeless challenge which all democratic societies face. Using Herbert Packer's models of the criminal justice process, this project compares the changes in search and seizure law which have occurred in the United States and Canada. The issue of what to do with evidence tainted by an illegal search and seizure clearly illustrates the tradeoffs countries are willing to make concerning citizen-police encounters. The alterations noted comprise more than a shift in Policy; they reveal changes in the basic premises of the respective criminal justice systems.

MACHADO, Priscilla, Assistant Professor, "The Dilemma of Crime," in *Law and Politics: Unanswered Questions*, NY: Peter Lang, (1994), 267-283.

This book chapter discusses the problem of controlling

crime while protecting the rights of those accused. Since the American criminal justice system serves two masters, both goals are shortchanged. The chapter also discusses the politics surrounding the reporting and combatting of crime. The difficulty in solving the crime problem is discussed in the uniquely American context. The systemic tradeoffs we make, and the interwoven problems of chronic poverty, poor education, inequality, and the like, make the solutions to crime more difficult than most Americans realize.

MACHADO, Priscilla, Assistant Professor, "The Sanctioning of Criminals: Punishment," in *Law and Politics: Unanswered Questions*, New York: Peter Lang, (1994), 285-308.

This book chapter discusses the political and legal problems associated with sanctioning criminals in the United States. The chapter raises the often confusing question of what is the goal of the penal system in the United States; rehabilitation, deterrence, retribution, or the like? Because we as a society cannot agree about the goal of punishment, the results have been less than promising. Many of our sanctions are unimaginative and ineffective. Today, prisons are severely overcrowded and most inmates return to society more violent and antisocial than when they entered. The chapter raises the unanswered question of how do we punish those that break the rules of society in such a way to discourage recidivism and protect the general welfare?

PURKITT, Helen E., Professor, editor, *Annual Editions: World Politics 94/5*, Sluice Dock, Conneticutt: Dushkin Publishing Group, (1994).

This book is the fifteenth edition of an annual collection of fifty articles about recent issues and trends in international affairs. This book is organized into eight subsections covering major current issues in each regional subsystem of the world and key policy issue areas related to the global economy, arms proliferation, and other global issues. Each section begins with an introduction which reviews key trends for the novice reader. This volume is used as a supplemental text in introductory courses in international relations, U.S. foreign policy, and national security issues.

PURKITT, Helen E., Professor, "Algeria," "Morocco," and "Tunisia," *Encyclopedia of Democracy*, Washington: Congressional Quarterly, Inc., (1995).

These brief (1,000 - 2,600 word) profiles are designed to provide readers with the requisite knowledge of

contemporary events and trends in each country relevant to the study of democracy. The profiles are an original and timely analyses of politics in these countries.

TOMLINSON, Rodney, Professor, *Reference Guide to the 48th (1993) United Nations General Assembly*, Washington: United States Department of State, (March 1994).

This is a reference document that analyzes and summarizes voting records of the members of the United Nations for the Forty-Eighth (1993) General Assembly.

All roll calls are studied and catalogued according to agenda, date, location, major and minor subjects, and important related incidents and issues in world affairs. A short descriptive passage is prepared and roll call votes for each number are appended. A series of cross-reference indexes are prepared to provide quick look by dates, resolution number, agenda number, location, and topical keywords. This document is published for use by members of the U.S. Diplomatic Corps and U.S. missions abroad to facilitate research into positions taken by the nations to which they are accredited.

Presentations

COCHRAN, Charles L., Professor, and Eloise F. MALONE, Assistant Professor, "Attitudes and Opinions Toward Ethical Behavior: Systematic Analysis of the Military, U.S. Naval Academy Political Implications," Midwest Political Science Association, Chicago, Illinois, 14-16 April 1994.

CURTIS, Willie, Associate Professor, "The Inevitable Slide into Coercive Peacemaking: The United States' Role in Peacekeeping in the New World Order," International Studies Association Conference, Maxwell Air Force Base, Alabama, 14-17 October 1993.

CURTIS, Willie, Associate Professor, "International Peacekeeping in the Post-Cold War Era," Pi Sigma Alpha Honors Awards Banquet, James Madison University, 19 April 1994.

CURTIS, Willie, Associate Professor, " Maneuvering in the Gray Zone: The Gap Between Peacekeeping and Warfighting," Norwich University, Northfield, Vermont, 24-25 February 1994.

HARFF, Barbara, Associate Professor, "A Theoretical Model of Genocides and Politicides," Workshop on Early Warning of Communal Conflicts and Humanitarian Crises, Center for International Development and Conflict Management, 5-6 November 1993.

HARFF, Barbara, Associate Professor, discussant, Early Warning, International Studies Association, Washington, D.C., March 1994.

HARFF, Barbara, Associate Professor, co-chair of workshop, Early Warning of Communal Conflicts and

Humanitarian Crises, Center for International Development and Conflict Management, University of Maryland, 5-6 November 1993.

HARFF, Barbara, Associate Professor, steering committee, Initiative on Genocides and Human Rights, American Sociological Society and Holocaust Research Institute, U.S. Holocaust Memorial Museum, Washington, D.C., 13-14 November 1993.

HARFF, Barbara, Associate Professor, "International Humanitarian Intervention in Domestic Strife: The Lessons of Bosnia, Cambodia and Somalia," American Society of International Law, Washington, D.C., 8 April1994.

HARFF, Barbara, Associate Professor, "International Implications of and Responses to Ethnic Conflict in Europe," The Interdisciplinary Program of Research on Root Causes of Human Rights Violations Symposium, 25 June 1993.

HARFF, Barbara, Associate Professor, study group participant, Preventive Diplomacy in the Post-Cold War Period: Challenges and Opportunities of the United States, United States Institute for Peace and U.S. Department of State Policy Planning Staff, U.S. Institute for Peace, Washington, D.C., 17 November, 6 December 1993, 11 January 1994.

HARFF, Barbara, Associate Professor, discussant, Theories of Ethnic Violence and Xenophobia, George Mason University, Fairfax, Virginia, 18-19 February 1994.

MALONE, Eloise F., Assistant Professor, "Integrating Ethics Across a Curriculum," Joint Service Conference on Professional Ethics, January 1994.

MALONE, Eloise F., Assistant Professor, "Into the 1990s: New Faces, New Order Quebec and the 1993 Election: The Basis and Implications of French Canadian Nationalism," International Studies Association Conference, Washington, D.C., 28 March - 1 April 1994.

MATTOX, Gale A., Professor, "European Security: Challenges for the Future," Washington Center Program, Washington, D.C., 3 January 1994.

MATTOX, Gale A., Professor, "National Security Strategy,: European Community Conference, Stuttgart, Germany, 14 March 1994.

MATTOX, Gale A., Professor, "A New Security Agenda for the United States and Europe," Northeast International Studies Association Annual Conference, Newark, New Jersey, 12 November 1993.

MATTOX, Gale A., Professor, "U.S. Foreign and Economic Policy Making in the Global Village: Institutions and Processes," Washington Center Program, Washington, D.C., 3 January 1994.

MATTOX, Gale A., Professor, "U.S. Interests in Europe," Salzberg Seminar, Salzberg, Austria, June 1993.

RACHWALD, Arthur R., Professor, "Polish-German Reconciliation After W.W.II," American Association for the Advancement of Slavic Studies (AAASS), Honolulu, Hawaii, November 1993.

RACHWALD, Arthur R., Professor, "Poland and the Visegrad Agreement," AAASS, Honolulu, HI, November 1993.

RACHWALD, Arthur R., Professor, "Political and Economic Transition in Central Europe. Poland: National Security and the Question of Integration into the European Community and NATO," Seminar on Political and Economic Transition in Central Europe, Brandeis University, February 1994.

PURKITT, Helen E., Professor, "The Cognitive Basis of Foreign Policy Expertise: Evidence from Intuitive Analyses of Politics in South Africa," American Political Science Association, Washington, D.C., 2 September 1993.

PURKITT, Helen E., Professor, "The Importance of Problem Identification or Framing in Foreign Policy Decision Making: Insights from Psychology and Political Science," International Studies Association, 30 March 1994.

SEATON, James B. III, Captain, USMC, Instructor, "Shedding Our Skin: Approaching Post-Modern Conflict," Inter-University Seminar on Armed Forces and Society, Baltimore, Maryland, 23 October 1993.

SEATON, James B. III, Captain, USMC, Instructor, "Social Warfare: The Setting for Stability Operations," International Studies Association, Washington, D.C., 1 April 1994.

ZOTTI, Priscilla, Assistant Professor, (with John C. Domino) "State Court Decisionmaking in the Area of Workplace Sexual Harassment," Southwestern Political Science Association, San Antonio, Texas, 1 April 1994.

Division of
Mathematics and Science

Captain Howard J. Halliday, USN
Director

Chemistry

Professor Boyd A. Waite
Chair

The faculty of the Chemistry Department continued this year to pursue innovative and state-of-the-art research efforts, both here at U.S. Naval Academy and through collaborative efforts with other Navy or government laboratories. A principle focus has been on involvement of midshipmen within the Chemistry major in these developing research projects. The ever-widening range of research instrumentation and computational facilities has opened up several new fields of investigation.

This year saw the inauguration of the Department's Laser/Molecular Beam Laboratory, under the direction of two of the newer members of the faculty. Significant results have already been obtained which show great promise for both midshipmen involvement as well as publication in scientific literature. The department will sponsor one Trident Scholar next year who will be directly involved in experimental beam studies involving gas-phase metal atom oxidation reactions.

Another area of significant interest to midshipmen within the Chemistry major has been directed by a relatively new biochemistry faculty member. Several semester research projects were completed during the year, focusing on various aspects of biochemical phenomena, with a special emphasis on organism development and cell biology.

The department's vast array of computational facilities has been put to great use during the year by a new faculty member, supported by a multi-year NSF Grant. This research involves high-end workstations, resulting in simulations of dynamical interactions of diamond structures with surfaces. With the interfacing of the sophisticated video recording equipment and software recently acquired by the department, these simulations will be presented in the form of actual animations of these atomic-level interactions. A post-doctoral student came just at the end of the academic year who will work intensively on this research project, in addition to supporting the teaching mission of the department. This is another first for the Chemistry Department.

The department continued to maintain strong ties with several Navy laboratories and other government institutions, including the Naval Research Laboratory, the Naval Surface Warfare Center, and the National Aeronautics and Space Administration. External grant support has been provided from the National Science Foundation.

In addition to those already mentioned, faculty interests cover a wide range of sub-disciplines within the field of Chemistry, including organic, solid-state, inorganic, and organometallic syntheses and characterization, low-temperature kinetic studies, electrochemical studies of metal-metal interactions, hazardous materials studies, theoretical studies of shock-wave propagation, theoretical biological studies of diffusional interactions in immunoassay systems, and theoretical studies of genetic code information and mechanisms for its transmittal. This wide range of interests helps to strengthen the Chemistry curriculum of the Naval Academy, producing graduates who are well prepared for the technical challenges of the Fleet.

Sponsored Research

Multidisciplinary Studies on Biological Information Systems

Researchers: Assistant Professor John W. Bodnar, Midshipman 1/C
Christopher Kuzniewski, USN, Midshipman 1/C William
Mann, USN, Midshipman 1/C Kennett Moses, USN
Sponsor: Naval Academy Research Council (ONR)

A fertilized egg contains all the information necessary to determine the identity of an adult animal, and the process of organismal development depends on a series of biochemical events to express that information into structural components of the organism. The information for development is stored in a hierarchy of forms: molecular information in DNA, cellular information in cell nuclei, and organismal information in tissues throughout the growing organism. Therefore, understanding the biochemistry of organismal development will require an integrated knowledge of biochemical pathways and compartmentalization of information at the molecular, cellular, and organismal levels. Knowledge of biological mechanisms for information access will not only provide a theoretical basis for understanding cancer and other diseases but also for formulating models to construct biochemical control systems.

The objective of this project is to collate current knowledge on information storage in biological systems to form an integrated theory of organismal development that deals with a growing organism as a biological information system. This research has combined theory, computer simulation, and laboratory experimentation to link together literature from diverse biological disciplines - forming new, integrated theories to be tested by computer simulation and new experimentation. Specifically, 1) literature compilation and computer simulation has just been completed and is being prepared for publication to identify the sequence of steps in the regulation of genetic information during the growth of the fruit fly embryo; and 2) literature compilation and lab experiments are in progress to develop an integrated theory on the molecular steps in reorganization of genetic information within the cell nucleus during the cell cycle and viral lytic cycle.

Reaction Dynamics of Gas-Phase Metal Atoms

Researcher: Associate Professor Mark L. Campbell
Sponsor: Naval Research Laboratory, Code 6110, Washington, D.C.

The general objective of this work is to investigate gas phase reactions of aluminum. The first reaction studied was the reaction of aluminum with carbon dioxide. The primary goal for studying this reaction was to determine the fractional yield of AlO product relative to the addition adduct, $Al \cdot CO_2$. Gas phase aluminum atoms were studied at temperatures and total pressures which varied from 300 to 500 K and 10 to 500 torr, respectively. The experiments were carried out in a four-way cross sample chamber heated inside a Blue-M convection oven. The aluminum atoms were generated by photolysis of trimethylaluminum (TMA) or triethylaluminum (TEAL) using the 193 or 248 nm pulse of an excimer laser. The AlO product was detected utilizing the band head of the $B^2\Sigma^+ - X^2\Sigma$ transition near 465 nm. Absolute laser-induced fluorescence intensities were measured as a

function of total pressure to obtain the pressure dependence of the absolute yield of AlO. Much was learned about the experimental difficulty associated with these types of measurements although no publishable results have been attained at present.

The second reaction studied was the reaction of aluminum atoms with NOCl. Gas phase aluminum atoms were at room temperature. The experiments were carried out in the same apparatus as the CO_2 experiments. The aluminum atoms were generated by photolysis of TMA at 248 nm. The aluminum atoms were monitored utilizing the $^2P^\circ - ^2S$ resonance line at 390 nm. Decay profiles of the aluminum atoms were obtained as a function of NOCl pressure. The reaction rate of NOCl was found to be very rapid.

CHEMISTRY

Study of Mercury Deposition on Platinum Using the Quartz Crystal Microbalance

Researcher: Professor Graham T. Cheek
Sponsor: Naval Research Laboratory, Code 6171, Washington, D.C.

The deposition of mercury onto platinum substrates was studied in order to determine the extent of interaction of the mercury with platinum under various conditions. Mercury was electrochemically deposited onto platinum. The resultant frequency changes were followed using the quartz crystal microbalance. It is of considerable interest to determine the characteristics of the platinum/mercury amalgam layer because of the analytical applications of mercury film electrodes. In addition, it is hoped that electrochemical reactions at mercury films can be followed using the microbalance.

Platinum films (200 nm) were prepared by evaporative deposition onto AT-cut 5 MHz quartz crystals. Mercury was deposited by electrochemical reduction of mercurous nitrate in aqueous perchloric acid solutions. As mercury deposition proceeded, the frequency was found to decrease markedly, reaching a minimum of several thousand Hertz. The frequency then increased and became constant at approximately two thirds of the minimum frequency. Such behavior indicates that mercury deposition initially causes a rather

large frequency decrease (mass loading). However, the quartz crystal shear wave penetration depth is rather quickly reached after which the frequency becomes constant with further deposition. Using coulometric measurements of the amount of mercury deposited, the mercury film thickness at the minimum frequency corresponds to the calculated value of the penetration depth for mercury films (90 nm). Upon stripping the mercury film from the substrate using a potential sufficient to oxidize bulk mercury, it was found that the frequency increased to within 2000 Hz of the initial value for the platinum film suggesting that some mercury remains in the film. Taking into account the amount of platinum in the film and the calculated mass/frequency response for mercury, the loading was found to be 10 mole percent mercury in platinum. This finding indicates that a "blocking layer" of platinum amalgam has formed which provides a relatively stable base for further mercury deposition. The thickness of this layer depends on the composition of the layer (i.e., PtHg vs PtHg$_4$) and is limited to a maximum value of 20 nm.

Preparation of Potential Anti-Viral and Anti-Toxin Agents

Researcher: Associate Professor Debra Dillner
Sponsor: United States Army Medical Research Institute of Infectious Disease Toxinology Division

The purpose of this research is to prepare potential anti-toxins and anti-viral compounds. These compounds will then be tested for biological activity at the Army Medical Research Institute of Infectious Diseases. The anti-viral compounds are in the category of substituted pyrimidine derivatives. These compounds contain a cyclopentane ring rather than a saccharide substituent and are expected to be more stable and have fewer side-effects than previously tested analogs. The anti-toxin compounds are

being investigated for use in treatment of ricin, botulism and tetanus. An active site analog for the ricin toxin is being synthesized. This compound contains a pyrazolo-[4, 3-d]- pyrimidine ring with a substituent on the pyrazole ring. The preparation of such compounds has not previously been explored. The preparation of a pyrazolo-[4, 3-d]- pyrimidine is being undertaken. Once this portion of the molecule is prepared, the introduction of a substituent will be investigated.

Navy Shipboard Hazardous Materials Minimization Program

Researcher: Associate Professor Frank J. Gomba
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

A program to minimize the number of hazardous materials used aboard U.S. Navy ships is underway at the Carderock Division, Naval Surface Warfare Center, Annapolis. A significant portion of this program has

been the identification of hazardous materials used in shipboard work centers and the establishment of a comprehensive database management system of shipboard hazardous material information.

The major accomplishment to date has been the consolidation of hazardous material and shipboard hazardous material application/use from various information resources into a comprehensive relational multi-user database management system. An additional database management system (PC based) has also been developed specifically to assist in qualitatively evaluating the hazardous materials to determine the least hazardous, technically capable materials to accomplish the required task. The hazardous materials have been grouped into primary- and sub-classes according to use and material type.

This initial report focuses on several recommendations to minimize Class I materials: Cleaning Compounds and Solvents (CC/S). Recommendations for minimization consider material substitution, elimination, consolidation or specification revision and development, and, if required, process changes.

The Atomic-Scale Friction and Wear of Diamond and Related Materials

Researcher: Assistant Professor Judith A. Harrison
Sponsor: Naval Academy Research Council (ONR)

Friction and the related phenomenon of wear are two of the more costly problems facing industry today. Understanding and ultimately controlling friction and wear has long been recognized as being central to many areas of technology. For instance, combustion engines break down and cutting tools become dull usually because of friction induced wear. Despite the obvious importance of friction and induced wear, much of the atomic-scale dynamics responsible for these phenomena remain elusive. If the atomic-scale origins of friction and wear were understood, this might ultimately lead to the design of materials with specific friction and wear properties.

With this in mind, this project has utilized molecular dynamics simulations to investigate the atomic-scale origins of friction and wear in diamond systems. When two atomically-flat, hydrogen-terminated diamond surfaces are placed in sliding contact, simulations have shown that the calculated friction depends on load, the crystallographic sliding direction, and temperature. The calculated friction is independent of sliding speed. The chemically-bound, flexible hydrocarbon groups on the surface of the diamond was shown to reduce friction as the load was increased.

More recently, it has been shown that wear of diamond surfaces can be initiated by the shearing of hydrogen atoms from the aforementioned chemisorbed hydrocarbon groups. Future work will involve the quantification of these and other wear mechanisms and the correlation of these mechanisms with experimental data.

Synthesis of Inorganic Molecular Solids with Unusual Electrical or Magnetic Properties

Researcher: Assistant Professor William B. Heuer
Sponsor: Naval Academy Research Council (ONR)

The potential use of homoleptic transition metal complexes of the dithiocroconate (cyclopentenetrione-1,2-dithiolato-) ligand and its derivatives as precursors for the formation of conductive and/or magnetic molecular crystals is being investigated. A series of tris complexes (M=Fe,Co,Cr) has been prepared and fully characterized, including full x-ray structure determinations. From the standpoint of electrical and/or magnetic properties, small cation salts of the corresponding bis-planar complexes (M = Ni, Pd, Pt) are expected to be more interesting, but to date, efforts to grow good quality crystals of these compounds have proven unsuccessful. Current efforts are focused on the use of cations which might be able to reduce the presumed unfavorable interactions between the complex anions by complexation or hydrogen bonding with the peripheral oxygen atoms. Examples of the cations being used are N-H donors such as ammonium, guanidinium and imidazolium cations, and hard cations of the alkali and alkaline earth families.

A series of derivatized complexes bearing dicyanomethylene substituents has also been prepared. The effects of this substitution on the electronic and crystallization properties of the complexes are being

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investigated.

High Pressure and Low Temperature Electrical Properties of β- and β''-Aluminas. Synthesis and Characterization of New Materials.

Researcher: Associate Professor Joseph F. Lomax
Sponsor: National Science Foundation

β- and β''-aluminas have a number of interesting properties, many of which arise because of the ability of these materials to incorporate a very large variety of ions into their structure. The incorporation of +1 ions is common in these materials and their ion conductivity has been widely measured. However, +2 ions are less commonly incorporated into solid state ionic materials and +3 ions have only been incorporated into β''-alumina. The limits to the charge of ions that can be incorporated into these materials has been expanded by this project. The work has demonstrated the ease by which +4 ions of titanium, zirconium and hafnium can be incorporated. The mechanism for ion movement and the preferred positions for the exchanged ions in the material has been investigated by dielectric measurements at low temperature and found to be quite intriguing. Other new materials with interesting optical properties are also being synthesized using trivalent rare-earth metals.

Synthesis and Structure of Hf-doped β''-Alumina β

Researchers: Associate Professor Joseph Lomax and
Assistant Professor Wayne H. Pearson
Sponsor: Naval Academy Research Council (ONR)

The reaction of crystalline, lithium-stabilized Na-β''-Alumina with hafnium (IV) chloride at $400\,^\circ C$ for 303 hours has caused sodium ions to exchange with hafnium ions. An X-ray crystal diffraction study of both the parent lithium stabilized Na-β''-alumina (1) and the partially zirconium exchanged product (2) have been made at 147 K. Crystal data for 1: rhombohedral, R3m, a = 5.6037 (3), c = 33.6210 (86), V = 914.31 (24). Crystal data for 2: rhombo-hedral, R3m, a = 5.5960 (6), c = 33.5821 (76), V = 910.7 (16).

Photochemically Induced Transformations of Transition Metal Complexes

Researchers: Associate Professor Joyce E. Shade and
Assistant Professor Wayne H. Pearson
Sponsor: Naval Academy Research Council (OMN and ONR)

Photolysis of the dinuclear complex $[(n^5-C_5H_5)Fe(CO)_2]_2$ in $CHCl_3$ results in the formation of $(n^5-C_5H_5)Fe(CO)_2Cl$ through intermediate 17-electron radicals of the form $(n^5-C_5H_5)Fe(CO)_2$. The photolyses of the related diphosphine-bridged compounds, $[(n^5-C_5H_5)Fe(CO)]_2$-u-DPPX, where DPPX = DPPM $(Ph_2P)_2CH_2$, DPPE $(Ph_2P)_2C_2H_4$, and DPPP $(Ph_2P)_2C_3H_6$, respectively, have been conducted in chloroform using ultraviolet light. In contrast to the simple iron carbonyl dimer, the phosphine bridged diiron compounds yield a golden dimeric product which contains the phosphine ligand intact as a bimetallic bridge. In the case of the DPPM and DPPE systems, incorporation of chloride ligands from the solvent into the isolated products is not observed. However, formation of a formyl substituent on one of the previously symmetrical cyclopentadienyl rings has been confirmed spectroscopically through infrared analysis, multinuclear magnetic resonance (NMR) and x-ray diffraction studies. The proposed mechanism for the formation of such a complex appears to involve a radical intermediate and follows a modified Reimer-Tiemann reaction. Such a pathway is believed to be unprecedented in the photochemistry of bimetallic complexes. In the case of the DPPP complex, the golden product that is isolated also contains the phosphine substituent as a bimetallic bridge. The bidentate ligand however appears to be too long to allow a metal-metal bond and the resulting product contains symmetrical

cyclopentadienyl rings on each iron center along with the chloride ligand and a carbonyl group.

In the synthesis and purification of the analogous ruthenium dimer, $[(n^5\text{-}C_5H_5)Ru(CO)]_2\text{-}u\text{-}DPPM$, and the attempted synthesis of the DPPE compound, $[(n^5\text{-}C_5H_5)Ru(CO)]_2\text{-}u\text{-}DPPE$, two ruthenium monomers

of the form $(n^5\text{-}C_5H_5)Ru(Cl)DPPX$ resulted. ^1H, ^{31}P and ^{13}C Nuclear Magnetic Resonance spectra have been obtained for both monomers. In addition, the structures of the two compounds have been verified using x-ray crystallography. Further synthetic studies are underway to produce the desired dimers in high yield.

The Development of Diffusional Kinetics Models for Describing Fiber Optics-based Immunoassays

Researcher: Professor Boyd A. Waite
Sponsor: Naval Research Laboratory, Code 6090, Washington, D.C.

A model has been developed for correctly describing the kinetics of binding of antigens to their corresponding antibodies which are bound to the surface of a fiber optics core (cladding removed). The model accounts for the hydrodynamic longitudinal flow along the axis of the fiber core, as well as the diffusional dynamics of interaction with the surface of the core. Binding is accounted for via a model previously developed for interactions of ligands with receptors anchored to surfaces. Various types of assays can be modeled corresponding to typical experimental methods used in fiber optics based immunoassay. Results compare very favorably with experimental results and provide explanations for various aspects of the kinetic phenomena, including the determination of binding parameters for antigen/antibody interactions.

Independent Research

Evaluation of a Novel Chloroaluminate Solvent System

Researcher: Professor Graham T. Cheek

A solvent system formed by addition of aluminum chloride to acetonitrile has been evaluated for use in electrochemical investigations. Upon addition of aluminum chloride to acetonitrile (AN), chloride anions are displaced from aluminum by AN, creating the cation aluminum bis(acetonitrilato) chloride and tetrachloroaluminate anions. The resulting solution is very conductive and has produced acceptable voltammograms for ferrocene redox behavior. Investigations are underway to define the acid/base behavior of this solvent system, particularly toward organic compounds added as solutes to the solution. It is hoped that this solvent system will be a convenient alternative to certain room-temperature molten salt systems.

Project Tanager

Researcher: Professor R. Reece Corey

This is a nationwide survey with Cornell University, Department of Ornithology, and many field observers to survey forest sites by acreage for breeding Scarlet and Summer Tanagers. This portion covers five sites in Kent County, Maryland and surveys territorial singing males, mated pairs, success of breeding, and estimates the percentage of cowbird parasitism.

CHEMISTRY

Catalytic Crystallization of Ices by Silicates at Low Temperatures

Researcher: Associate Professor Robert F. Ferrante

This project explored some of the findings of the previous summers work at National Aeronautics and Space Administration (NASA), Goddard Space Flight Center. The formation of *crystalline* water or methanol ice when the vapors are deposited onto a film of small (20-40 nm) silicate particles at 20 K clearly shows activity of the surface; depositions on polished Al produce only *amorphous* ice layers, which can be crystallized only by heating the material to 140-155 K. Similar crystallization behavior was observed for other volatiles (NH_3, CO_2, SO_2) deposited on silicate smokes. It was hypothesized that crystallization may have occurred as a result of the energy liberated at the ice/silicate interface, perhaps due to weak bonding of the ice to defect sites in the grains. This is enhanced by the high defect concentration and surface/volume ratio of the silicate substrates.

The variety of volatiles studied was increased and a number of different experiments were performed in an attempt to determine the cause of the effect. Variation of smoke thickness, sample loading, degree of silicate oxidation, rate and temperature of deposition, etc., were tested and evaluated. Because of the method of production, oxygen vacancies may be the predominant defect in the amorphous silicate coatings and thus may be the source of the catalytic crystallization activity. The effect was slightly dependent on aging of the samples and largely independent of the silicate thickness. Numerous tests were used to try to eliminate thermal effects as the cause. Surface area measurements were made and work was done on ground (large-grain) powder surfaces. Much of this is expected to continue under a newly-awarded grant. Since the method of the silicate particle production is general, oxide articles of other metals of astrophysical importance, i.e., (Mg, Fe) will be produced and tested for catalytic crystallization activity. Additionally, other types of defects will be introduced into these oxides to examine the behavior of those surfaces.

Oxygen Activation by Sterically Hindered Tetraazaporphyrins

Researcher: Associate Professor Jeffrey P. Fitzgerald

Molecular oxygen, O_2, is an inexpensive and thermodynamically powerful oxidant. Unfortunately, O_2 is also a kinetically slow oxidant. The "dual" nature of oxygen makes it of limited use to the synthetic chemist; typically it is unreactive and when it does react, it is completely unselective. Nature, however, has developed catalysts (enzymes) which allow it to use dioxygen efficiently. Most of these enzymes contain iron porphyrins at their active sites. For this reason metalloporphyrins and their analogs have significant potential as O_2 activation catalysts. One family of porphyrin analogs, metallotetraazaporphyrins, are particularly promising due to their oxidative stability and positively shifted redox couples.

This research project involves the synthesis of new metallotetraazaporphyrins and the study of these materials as O_2 activation catalysts. Additionally, it shows that planar tetraazaporphyrin complexes of iron (II) and manganese(II) will react with oxygen. Unfortunately, this reaction could not be made catalytic, the metallotetraazaporphyrin being converted to an inactive μ-oxo dimer. In order to prevent dimer formation, a sterically hindered tetraazaporphyrin, one bearing bulky substituents on the macro-cycle periphery, has been synthesized. The iron complex of this hindered tetraazaporphyrin has been shown to be incapable of forming a μ-oxo dimer. Surprisingly, the iron(II) complex also shows no reaction with O_2. This means that the previously observed reaction between planar iron(II) tetraazaporphyrins and oxygen must be driven by dimer formation. Complexes of the sterically hindered tetraazaporphyrin containing more oxophilic metals as O_2 activation catalysts are currently under study. The ruthenium (II) complex has been shown to react with oxygen without forming the μ-oxo dimer. It remains to be seen if this reaction can be made catalytic.

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Synthesis and Characterization of Ferrocenyl Disulfide Polymers

Researcher: Assistant Professor William B. Heuer

A possible photochemical route to deposition of ferrocenyl disulfide polymers is being investigated. Photochemical initiation would have several advantages over the current chemical method, including better control over the polymerization reaction, the ability to conduct the polymerization in solution or in the solid state, and the ability to form patterned microstructures. The electronic and magnetic properties of oxidatively doped polymers are also being investigated. Recent

studies of electron transfer in mixed-metal disulfide-bridged complexes have demonstrated the ability of the disulfide linkage to provide a pathway for the conduction of electrons. Thus it is anticipated that large increases in the conductivity of polymer films may be realized by chemical doping, for example with iodine. The nature of the magnetic interactions within the doped films are being probed by variable temperature susceptibility and electron spin resonance measurements.

Oxidation Reaction Kinetics of $Mo(^7S_3)$

Researcher: Assistant Professor Roy E. McClean

The reaction kinetics of ground state molybdenum atoms, $Mo(^7S_3)$, with several oxygen containing molecules are investigated to determine the oxidation reaction mechanisms of molybdenum. Molybdenum is used as a catalyst in oxidative and other catalytic processes. Kinetics investigations in the gas phase could provide a basis for understanding catalysis. Additionally, the studies reported here provide fundamental information on chemical kinetics. A laser photolysis/laser-induced fluorescence technique is used. $Mo(CO)_6$ is photodissociated with an excimer laser. The $Mo(^7S_3)$

atoms formed are monitored by laser-induced fluorescence. Preliminary results indicate that $Mo(^7S_3)$ reacts with O_2 with a room temperature rate constant on the order of 10^{-11} cm^3 s^{-1} at a total pressure of 20 Torr (argon buffer gas).

The laser chemistry laboratory where the experiments are conducted is still in the "setting up" stage. When the laboratory is fully operational, an extensive investigation of the reaction kinetics of $Mo(^7S_3)$ with O_2, CO_2, SO_2, NO, N_2O, and NO_2 will be conducted.

Photochemical Study of Cyano-Isocyanide-Phosphine Complexes of Iron and Ruthenium

Researcher: Associate Professor Joyce E. Shade

The chemistry of carbonyl-cyano-phosphine complexes of iron has been studied extensively for the last ten years. In general, reflux or photolytic reaction conditions have been employed to initiate the loss of a carbonyl (CO) group from cyclopentadienyl-iron-carbonyl starting materials with a subsequent inclusion of a phosphine or phosphite ligand on the metal center. The resulting complexes, however, all contain at least one carbonyl group. The purpose of this research was to prepare a series of anionic, neutral and cationic cyano, mono- and bisisocyanide complexes for reaction with phosphine or phosphite groups under photolytic conditions.

Photolysis of the monoisocyanide complex, $(n^5\text{-}C_5H_5)Fe(CO)(CN)(CNCH_3)$, in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product $[(n^5\text{-}C_5H_5)Fe(CN)(CNCH_3(PPh_3)]$ with loss of one

equivalent of carbon monoxide. However, two additional products have been obtained: $(n^5\text{-}C_5H_5)Fe(CNCH_3)_2(CN)$ and $(n^5\text{-}C_5H_5)Fe(CN)(PPh_3)_2$. Similar results were obtained with a variety of phosphine, phosphite, arsine and antimony ligands. Several of the reaction products have been isolated from the fairly clean reaction mixtures and a variety of spectral data has been obtained to verify their identity. Further purification and characterization of these compounds is continuing. In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic rating materials are being investigated under various reaction conditions in order to analyze the system

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for trends which might develop as a function of complex charge. A collaborative effort with Professor Antony Rest at The University in Southampton hoped to conclusively identify the reaction intermediate(s). The results have been very promising and the identity of the reaction intermediate has been postulated as a result of low-temperature matrix isolation studies. Work is continuing with a new focus on the analogous ruthenium species. Manuscripts on the synthetic portion and the spectroscopic matrix work are being prepared. Final spectral data is being obtained for inclusion in the papers.

Diphosphenes and Diarsines in Cluster Synthesis

Researcher: Associate Professor Joyce E. Shade

This project investigates the synthetic pathways possible for the generation of cyclopentadienyl-ruthenium complexes containing n^2-diarsene ligands. Complexes of this type which contain chromium, molybdenum, and tungsten have been investigated by several research groups. Recently, complexes containing zirconium, niobium and tantalum as the metal centers have been successfully synthesized, isolated in very small yields and characterized by Nuclear Magnetic Resonance (NMR) and X-ray diffraction studies. These complexes are interesting due to the fact that the di-hapto ligand would be isolobally analogous to an organic olefin.

Experimental work has been started and the $[Cp^*RuCl_2]_n$ starting material has been synthesized in reasonable yields. Synthesis of the cycloarylarsine, cyclo-(TolAs), has been accomplished following reported literature methods that begin with p-toluidine. The p-toluidine is converted to p-toluidine diazonium perfluoroborate which is then converted to p-tolylarsonic acid using As_2O_3. Final isolation of the cyclic tolylarsine is accomplished through a reduction of the acid solution using hypophosphorous acid. The arsenotoluene product which is obtained is a mixture of both the five- and six-membered rings in various ratios. Reactions of the cyclotolylarsine with the polymeric ruthenium species mentioned above have been attempted under various experimental conditions. Because of the polymeric nature of the metal starting material and the mixed stoichiometry of the arsine species, it is difficult to determine the exact reaction conditions needed to insure reaction of the compounds rather than decomposition of one or both of the starting materials. Project work is still in progress. This research was supported by Professor Arnold L. Rheingold of the University of Delaware.

Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls

Researcher: Associate Professor Joyce E. Shade

Previous work examined the synthesis and chemistry of substituted cyclopentadienyl metal compounds in which simple functional substituents were introduced at one or two of the carbons of the 5-membered cyclopentadienyl ring. This research focused on the chemistry of molybdenum and tungsten carbonyl compounds containing sterically encumbered pentaphenylcyclopentadienyl rings. $[(Ph_5C_5)Mo(CO)_3]_2$ forms an equilibrium with two $(Ph_5C_5)Mo(CO)_3$ radical species $[(Ph_5C_5)M(CO)_3]_2$, where M = Mo or W, is prepared following a low-temperature anion oxidation route. Photolysis of the metal-metal bonded dimers in the presence of a chlorocarbon gave $(Ph_5C_5)M(CO)_3Cl$ derivatives, as expected by radical reactions. Both the molybdenum and tungsten hexacarbonyl dimers demonstrated thermal and photochemical carbonyl loss to give tetracarbonyl, triply bonded derivatives. Reaction of the $(Ph_5C_5)M(CO)_3$ anions with R-Cl, where R = CH_3, CH_2Ph, and $_2CH$ -CH=CH , yield the expected $(Ph_5C_5)M(CO)_3R$ derivatives. The use of allyl bromide, however, was found to yield the unexpected product of $(Ph_5C_5)M(CO)_3Br$. Photolysis of $(Ph_5C_5)M(CO)_3$-CH_2-CH=CH_2 gives the tri-hapto-allyl derivative in good yield. Reaction of the metal $(Ph_5C_5)M(CO)$ anions with HBF_4 gave the corresponding hydridic species. Although all the compounds synthesized in this study have been found to be remarkably stable in air, there is no other obvious effect on the chemistry resulting from the protective umbrella of the Ph_5C_5 ligand. This research was supported by Professor Arnold L. Rheingold of the University of Delaware.

Research Course Projects

Preparation of Pyrazolopyrimidiness for the Synthesis of Toxin Inhibitors

Researcher: Midshipman 1/C Russell A. Crow, USN
Adviser: Associate Professor Debra Dillner

Substituted pyrimidines have shown promise as possible antitoxin compounds. Earlier research by United States Army Medical Research Institute of Infectious Disease has suggested that toxins such as ricin might be inhibited by the use of such compounds. Molecular modeling suggests that an effective inhibitor should contain a pyrazolo-[4,3,d]-pyrimidine ring. These potential inhibitors also have a hydrocarbon side chain with other functional groups to find near the toxin active site. It seems reasonable to believe that electrophilic aromatic substitution would be an effective path for the addition of substituent groups on the pyrazolopyrimidine ring system. This project concentrated on the synthesis of the parent pyrazolopyrimidine ring system. Although these compounds have been described in the literature, further work on the synthesis of the parent compound was needed. Additionally, this synthetic effort aided in gaining experience in techniques of characterization of heterocycles.

The first step in the synthesis required nitration of 3-methylpyrazole. Three variations on this procedure were tried and it was determined that nitration using fuming nitric acid and fuming sulfuric acid with a basic work-up gave the most satisfactory results on a large scale. The desired product was obtained in 75% yield following continuous extraction of the aqueous reaction mixture with ethyl acetate.

The second step was the oxidation of the methyl group to a carboxylic acid. Potassium permanganate oxidation worked very well, producing either the potassium salt of the acid or the free acid upon acidification. Again the yield was greater than 75%.

The most challenging step of this semester's project was the esterification of the acid to produce the ethyl ester. Standard conditions using ethanol in benzene with an acid catalyst were unsuccessful due to the insolubility of the acid in benzene. The primary product was recovered carboxylic acid. Alkylation of the potassium salt with methyl iodide was also unsuccessfully attempted. Preparation of the ester under equilibrium conditions gave the best results. Approximately 60% of the acid was converted to the ester and the remaining 40% was recovered as unreacted acid. This acid could be recycled to give additional ester. All compounds produced were characterized by NMR, IR, Mass Spectrometry, and melting point and were consistent with literature values.

Investigations of the conversion of this ester to the desired pyrazolo-[4,3,d]-pyrimidine system are continuing.

Gas Phase Oxidation Reactions of Transition Metal Atoms

Researcher: Midshipman 2/C James Harter, USN
Adviser: Associate Professor Mark L. Campbell

To further understand the dynamics of transition metal oxidation reactions, a temperature dependent kinetic study of the neutral transition metal atoms molybdenum and tungsten has been initiated. Reactants are oxygen-containing oxidants and halogens. By obtaining Arrhenius parameters for these reactions, steric factors and energy barrier effects can be distinguished. Reaction rates are being investigated as a function of temperature and pressure using a laser photolysis/laser-induced fluorescence technique. Transition metal atoms are produced by the 193 or the 248 nm photodissociation of the transition metal precursor (WF_6 for W, MoF or $Mo(CO)_6$ for Mo) using the output of an excimer laser. The stainless steel reaction cell with sapphire window is contained in a commercial convection oven for temperature dependence measurements. Ground-state and low-lying excited-state transition metal atoms are detected via laser-induced fluorescence (LIF) utilizing the output of a excimer pumped dye laser. LIF is monitored perpendicular to the counterpropagated laser beams by a

photomultiplier tube and captured by a gated boxcar sampling module. The delay time between the photolysis laser pulse and the dye laser probe is varied by a digital delay generator. The experimental set-up has been completed and computer programs are now being written for data collection. The rate constant as a function of temperature for Mo reacting with O_2 has been roughly determined.

NMR Order Parameters in Uniaxial Systems for the Carbon-Carbon Bonds of Alkyl Chains

Researcher: Midshipman 1/C Keith E. Hartman, USN
Adviser: Assistant Professor Ronald E. Siatkowski

All the obtainable information on molecular orientational order may be described by a second rank tensor known as an order parameter tensor. The order parameter tensor has been exploited for structural studies of small molecules. More recently, it has been measured for the rigid aromatic cores of the host molecules of some thermotropic liquid crystals, with the purpose of specifying the orientation of the "molecular axis" with respect to the director (long axis of the molecule). The systematics for the set of order parameter tensors which are necessary to describe a flexible molecule were explored. A flexible molecule, like a uniaxial liquid crystal, consists of moieties which are in themselves rigid, such as phenyl rings, methylene moieties, etc. Each such moiety will have its own order parameter tensor. The order parameter tensor for each rigid moiety must reflect the time-averaged point symmetry of the unit. For an alkyl chain in a uniaxial system, the order parameter tensor for every methylene unit can be determined by analysis of a sufficiently large set of order parameters. Order parameters are numbers that denote the amount of

ordering within the molecule. Such data can be provided by dipolar and quadrupolar splittings obtained from nuclear magnetic resonance spectroscopy. In the case where the methylene group has a time-averaged plane of symmetry, the complete set of input data required to specify the tensors consists of: 1) a set of order parameters of HH and CH internuclear vectors, and 2) the order parameter for only one C-C bond of the chain. The order parameter of the C-C bond vector propagates according to a sum rule. Diagonalization of the order parameter tensor for each moiety transforms the tensor into principal form. It appears that the principal axes are the "true" measure for the amount of orientational order of the entire molecule. The results of the nematic phase of 4-n-octyl-4'-cyano-biphenyl (8CB) show that the order parameter for the C3 axis of the methyl group predicts, in agreement with experiment, the order parameter for the long axis of the biphenyl ring moiety. The principal values and principal axis of the order parameter tensor for every rigid sub-unit of 8CB in its nematic phase are now known.

Proton Donor Characteristics of a Room-Temperature Molten Salt

Researcher: Midshipman 1/C Julie A. Spencer, USN
Adviser: Professor Graham T. Cheek

This work has demonstrated that the cation in the molten salt system aluminum chloride, 1-ethyl-3-methylimidazolium (EMI) chloride, can act as a proton donor toward various electro-generated bases. This aspect of molten salt electrochemistry is very important because the reduction products of many organic compounds are rather basic. In this study, the EMI cation was deuterated in the 2 position by dissolving the chloride salt in D_2O. After evaporation of the solvent and purification of the salt, a basic melt (molar excess of EMI) was prepared, and a reduction of benzophenone

was carried out. The product which was isolated, benzhydrol, was found to be deuterated, indicating that uptake of deuterium from the melt cation had indeed occurred. Similar results were obtained for anthracene, the reduction of which gave dihydroanthracene in the usual melt and dideuterioanthracene in the deuterated melt. Trityl chloride reduction gave triphenylmethane of which the carbon was deuterated. These studies confirm that the EMI cation can donate protons to electrogenerated bases.

Publications

BODNAR, John W., Assistant Professor, "The Military Technical Revolution: From Hardware to Information." *Naval War College Review*, 44(3) (Summer 1993), 7-21.

The conduct of war has changed dramatically between World War II and Operation Desert Storm. The major differences resulted from a revolution in military technology. This "Military Technical Revolution" (MTR) has undergone three distinct phases, which started at different times, stand today at different stages, and accordingly will culminate (or have already) at different times: a military engineering revolution, a military sensor revolution, and a military communications revolution. Analysis of the characteristics of each type of revolution on the technology, operations, and organization of the military has indicated specific ways in which the effectiveness of any military fighting force in the year 2003 will depend on integration of hardware, sensors, and communications in ways that are totally different from even ten years ago.

CAMPBELL, Mark L., Associate Professor, co-author, "Kinetics of Neutral Transition-Metal Atoms in the Gas Phase: Oxidation Reactions of $Ti(a^3F)$ from 300 to 600 K," *Journal of Physical Chemistry*, 97 (July 1993), 7942-7946.

Gas phase kinetics are reported for the reactions of $Ti(a^3F)$ with O_2, N_2O, NO, CO_2, SO_2 and NO_2 from 300 to 600 K. Titanium atoms were produced by the photolysis of $TiCl_4$ at 248 nm and were detected by laser-induced fluorescence. Arrhenius expressions obtained for these reactions at a buffer gas pressure of 20 Torr are $k(O_2) = (1.69\pm0.41)\times10^{-10}\exp(-(11.6\pm0.8$ kJ/mol)/RT) cm^3s^{-1}, $k(N_2O) = (1.74\pm0.44)\times10$ $\exp(-(14.3\pm0.9$ kJ/mol)/RT) cm^3s^{-1}, $k(NO) = (3.28\pm0.69)\times10^{-11}\exp(-(3.62\pm0.71$ kJ/mol)/RT) $cm^3 s^{-1}$, $k(CO_2) = (7.0\pm1.6)\times10^{-11}\exp(-(14.9\pm0.8$ kJ/mol)/RT) cm^3s^{-1}, and $k(SO_2) = (1.70\pm0.33)\times10^{-10}\exp(-(2.66\pm0.64$ kJ/mol)/RT) cm^3s^{-1}. The rate constant of Ti with NO_2 was found to be temperature independent from 300 to 500 K with a value of $(9\pm4)\times10^{-11}$ $cm^3 s^{-1}$. Quoted uncertainties are $\pm2\sigma$. With the exception of $Ti + O_2$, all reactions were investigated as a function of pressure. Only the reactions of Ti with NO and CO_2 were found to depend on the argon buffer gas pressure. Termolecular rate constants at 300 K were determined to be $(5.8\pm2.6)\times10^{-31}$ cm^6s^{-1} and $(3.5\pm1.0)\times10^{-32}$ cm^6s^{-1} for NO and CO_2, respectively.

CAMPBELL, Mark L., Associate Professor, co-author, "Kinetics of the Reaction $Al(^2P^\circ) + H_2O$ over an Extended Temperature Range," *Journal of Physical Chemistry*, 97 (September 1993), 9673-9676.

The temperature dependence of the reaction $Al(^2P^\circ) + H_2O$ has been investigated over the temperature range 298-1174 K. Aluminum atoms were produced by photodissociation of $Al(C_2H_5)_3$ and were detected by laser-induced fluorescence. Nonlinear Arrhenius behavior is observed, and the measured rate constants can be described by the expression $k(T) = (1.9\pm1.5)\times10^{-12}\exp[-0.88\pm0.44$ kcal mol^{-1})/RT] + $(1.6\pm0.7)\times10^{-10}\exp[-(5.7\pm0.9$ kcal mol^{-1})/RT] $cm^3 s^{-1}$, where the uncertainties represent $\pm2\sigma$. At room temperature, the rate constant is pressure independent between 10 and 110 Torr total pressure (Ar buffer gas). Results are interpreted in terms of two metathesis reactions with different Arrhenius parameters, one yielding AlO and the other AlOH.

CHEEK, Graham T., Professor, co-author, "Measurement of H/D Uptake Characteristics at Palladium Using a Quartz Crystal Microbalance," *Journal of Electroanalytical Chemistry*, 368 (1994), 133-138.

Frequency measurements at AT- and BT-cut crystals have been carried out for electrolytic loading of palladium films with H and D from 0.10M LiOH + H_2O (0.10 M LiOD + D_2O) solutions. The results at BT-cut crystals have shown that film stressing occurs during the early part of H or D deposition and that this stressing is largely reversible upon removal of hydrogen species. In experiments involving addition of H_2O to D_2O solutions, it has been found that deposition of H into the palladium film is favored over that of D and that H uptake occurs exclusively at H_2O levels above 10%. However, these experiments have been carried out at much lower current densities than are typical for these investigations.

CHEEK, Graham T., Associate Professor, co-author, "Electrochemical Studies of Indigoid Systems," Proceedings of the Electrochemical Society, PV93-11 (1993), 165-174.

Electrochemical studies of the indigoid systems, indigo, indigo carmine, and Tyrian Purple have been carried out principally in alkaline solutions. The electrochemical behavior of Tyrian Purple is of particular interest because it was used in ancient times as a dye, being converted to

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the leuco or reduced form during processing. The electrochemical activity of these systems is due to the conjugated diketone structure which gives rise to reversible electron transfers. Redox potentials for the Tyrian Purple system have been determined in an effort to discover the most likely reducing agent to be employed in the ancient process. The electrochemical parameters for such common reducing agents as lead, tin, and iron have been investigated in this regard. It has been found that the tin system is thermodynamically the most powerful reducing agent in the examples studied, although other factors also play a role in providing a reducing agent of practical utility.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Relationship between Changes in Serum Thyrotropin, Total Cholesterol, and Lipoprotein Cholesterol with Prolonged Antarctic Residence," *Metabolism*, 42 (1993), 1159-1163.

Antarctic residence (AR) is associated with a 50% increase in the thyrotropin (TSH) response to TSH-releasing hormone (TRH) and an expanded triiodothyronine (T_3 distribution volume and extravascular hormone pool, collectively called the polar T_3 syndrome). To investigate the possible biologic significance of this syndrome, a study was conducted on the relationship between nonstimulated TSH and serum lipid profiles in nine subjects, once while in California and monthly during 9 months of AR. Serum levels of TSH, total thyroxine (TT_4), free T_4 (FT_4), total T_3 (TT_3), free T_3 (FT_3), thyroid-binding globulin (TBG), total cholesterol (T-CHOL), high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), dietary cholesterol (D-CHOL), dietary fat (D-FAT), and dietary kilocalories were measured each month. The paired mean monthly change from baseline was used to determine significance. The group's mean levels of TSH (~30%), TBG (~16%), T-CHOL (~4%), HDL-C (~10%), and D-CHOL (~19%) increased with AR($p<.05$). Small but significant decreases ($p<.05$) were observed in the mean changes of TT_4(~8%), FT_4(~6%), and TT_3(~6%). FT_3, D-FAT, dietary kilocalories, body weight, TG, and the calculated low-density lipoprotein (LDL-C) were unchanged with AR. A significant rate of change ($p<.05$) during AR was also calculated from the slope of a fitted logarithmic function for TSH (0.96 ± 0.31 $mU \cdot L^{-1} \cdot mo^{-1}$), TBG ($61.19 \pm 12.29$ $nmol \cdot L^1 \cdot mo^1$), TT_3 (0.09 ± 0.04 $nmol \cdot L^{-1} \cdot mo^{-1}$), TT_4/TBG(-0.06 $\pm$ 0.01/mo),TT_3/TBG(-8.49 $\pm$ 1.98 X 10^{-4}/mo), and TG(-0.33 $\pm$ 0.15 $mmol \cdot L^{-1} \cdot mo^{-1}$). Individual TSH changes with AR for the nine subjects varied and were highly correlated with paired changes in T-CHOL (r=.628,

n=81,p<.001) and similar changes in LDL-C(r=.658,n=81,p<.001). No correlation was found between D-CHOL and serum lipid levels. The study suggests that AR is associated with asymptomatic environmentally related thyroid alterations that correlate with metabolic markers (T-CHOL and LDL-C) of thyroid hormone activity in hepatic and adipose tissues.

FERRANTE, Robert F., Associate Professor, co-author, "Infrared Spectra of Crystalline Phase Ices Condensed on Silicate Smokes at T < 20 K," *Astrophysical Journal*, 428, (June 1994), L143-L146.

Infrared spectra of H_2O, CH_3OH, and NH_3 condensed at T < 20 K on amorphous silicate smokes reveal that predominantly crystalline phase ices form directly on deposit. Spectra of these molecules condensed on aluminum substrates at T < 20 K indicate that amorphous phase ice forms. On aluminum, crystalline phase H_2O and CH_3OH are formed by annealing amorphous deposits to 155 K and 130 K, respectively (or by direct deposit at these temperatures); crystalline NH_3 is formed by direct deposit at 88 K. Silicate smokes are deposited onto aluminum substrates by evaporation of SiO solid or by combustion of SiH_4 with O_2 in flowing H_2, followed by vapor phase nucleation and growth. Silicate smokes which are oxygen-deficient may contain active surface sites which facilitate the amorphous-to-crystalline phase transition during condensation. Detailed experiments to understand the mechanism are currently in progress. The assumption that amorphous phase ice forms routinely on grains at T < 80 K is often used in models describing the volatile content of comets or in interpretations of interstellar cloud temperatures. This assumption needs to be reexamined in view of these results.

FITZGERALD, Jeffrey P., Associate Professor, co-author, "Heterometallic and Homometallic Ruthenium and Osmium Double Bonds in Metalloporphyrin and Metallotetraazaporphyrin Dimers," *Journal of the American Chemical Society*, 115 (1993), 9309-9310.

Studies of multiple metal bonds in discrete complexes provide fundamental insight into the nature of metal-metal bonds. However, few compounds containing ·heterometallic multiple bonds have been reported and no general method for the synthesis of such compounds exists. A report was made of the synthesis of [Ru(OETAP)]₂, [Os(OETAP)]₂, [(OEP)RuRu(OETAP)] and [(OEP)OsRu(OETAP)] where OEP = octaethylporphyrin and OETAP = octaethyltetraazaporphyrin. A report was also made of the general method for the isolation of heterodimers

based on a series of redox titrations made possible by the different redox potentials which the metal and/or ligand confer upon the complexes. The heterodimers exhibit spectroscopic and magnetic properties consistent with a bond order of two and a spin state of one as predicted by molecular orbital theory.

FITZGERALD, Jeffrey P., Associate Professor, "Cyclooctane Conformational Analysis Via Mechanical and Computational Models," *Journal of Chemical Education*, 70 (1993), 988-990.

A laboratory exercise in which students use both handheld, mechanical models and computational models to explore the molecular shape of cyclooctane is presented. The handheld models help students visualize the three dimensional arrangement of atoms in various conformations of cyclooctane and how these arrangements cause differing amounts and types of strain (bond, angle, torsional and van der Waals). The computational models (i.e. molecular mechanics calculations) complement the students understanding by quantifying the various types of strain in each conformation.

FITZGERALD, Jeffrey P., Associate Professor, co-author, "Formation and Reactivity of (Octaethyltetraazaporphyrinato)-rhodium Complexes," *Inorganic Chemistry*, 33 (1994), 2029-2035.

A series of (octaethyltetraazaporphyrinato)rhodium complexes including Rh(OETAP)I, Rh(OETAP)CH$_3$ and [(OETAP)Rh]$_2$ were prepared for comparison to the corresponding (octaethylporphyrinato)-rhodium, (OEP)Rh, complexes. [(OETRAP)Rh]$_2$ (1) reacts like [(OEP)Rh]$_2$ (2) with CH$_3$I, CH$_3$NC, (CH$_3$O) P, and CH$_2$=CH$_2$ but reactions of 1 are invariably much slower than those of 2. [(OETAP)Rh]$_2$ fails to react with H$_2$, CO, CH$_3$CHO and CH$_3$C$_6$H$_5$, all of which react rapidly with 2. Reactivity and equilibrium studies indicate that a higher Rh-Rh bond dissociation enthalpy for 1 compared with 2 is primarily responsible for the slower rates and the reduced scope of reactions for [(OETAP)Rh]$_2$. Differences in the reactivities of (OETAP)Rh and (OEP)Rh complexes are discussed in terms of the smaller hole size, lower energy of the π* orbitals and doming of the OETAP ligand.

LOMAX, Joseph F., Associate Professor and Wayne H. Pearson, Assistant Professor, "X-ray Crystal Diffraction Study of Zr, Na-β"-Alumina," *Material Research Society Symposium Proceedings*, 293 (1993), 315.

The reaction of crystalline lithium-stabilized Na-β"-Alumina with zirconium (IV) chloride at 400°C for 303 hours has caused sodium ions to exchange with zirconium ions. An X-ray crystal diffraction study of both the parent lithium stabilized Na-β"-alumina (1) and the partially zirconium exchanged product (2) have been made at 147 K. Crystal data for 1: rhombohedral, R$\overline{3}$m, a = 5.6037 (3), c = 33.6210 (86) Å, V = 914.31 (24) Å^3. Crystal data for 2: rhombohedral, R$\overline{3}$m, a = 5.5994 (5), c = 33.7711 (51) Å, V = 916.96 (16) Å^3. Zirconiums in 2 reside, predominately, in the Beevers-Ross type site.

MCCLEAN, Roy E., Assistant Professor, coauthor, "Production and Decay of PbI(g) from the 308 nm Photodissociation of PbI$_2$(g)," *Journal of Physical Chemistry*, 98 (1994), 1864.

An extensive investigation of the production and decay of ground-state PbI(g) molecules from the 308-nm XeCl excimer laser photodissociation of PbI$_2$(g) is reported. The laser fluence dependence of the PbI yield along with energetic considerations suggest that PbI is produced by a one-photon process. PbI decay profiles as a function of argon pressure, PbI$_2$ pressure, laser fluence, and cell temperature were determined. These results suggest that PbI and the other likely photodissociation product, I, decay back to PbI$_2$ by a complex mechanism involving an exothermic preequilibrium. A complex mechanism was proposed that includes the PbI$_2$-catalyzed recombination of PbI and I and the dimerization of PbI molecules. The proposed mechanism also takes into account the presence of Pb formed from the two-photon photodissociation of PbI$_2$ and is capable of reproducing the observed PbI(g) and Pb(g) decay profiles under most conditions studied when reasonable values of rate constants for the various elementary steps are used.

MCCLEAN, Roy E., Assistant Professor, coauthor, "Kinetics of the Reactions VO(X$^4\Sigma^-$) + O$_2$, NO, and CO$_2$," *Chemical Physics Letters*, 215 (1993), 209.

The kinetics are reported for the gas-phase reactions of VO(X$^4\Sigma^-$) with O$_2$, NO, and CO$_2$ at 297, 394, and 531 K, and at total pressures up to 165 Torr using argon bath gas. VO was produced by the multiphoton dissociation of VOCl$_3$(g) at 193 nm and was detected by laser-induced fluorescence. Measured rate constants for all reactions exhibited a slight negative temperature dependence, and only the VO + NO reaction was found to be pressure dependent. Results are interpreted in terms of the reactions going through an intermediate which subsequently falls apart to VO$_2$ or collisionally stabilizes.

MCCLEAN, Roy E., Assistant Professor, and Mark L. CAMPBELL, Associate Professor, coauthors, "Kinetics of the Reaction Al($^2P°$)+ H_2O Over an Extended Temperature Range," *Journal of Physical Chemistry*, 97 (1993), 9673.

The temperature dependence of the reaction Al($^2P°$) + H_2O has been investigated over the temperature range 298 - 1174 K. Aluminum atoms were produced by photodissociation of Al(C_2H_5)$_3$ and were detected by laser-induced fluorescence. Nonlinear Arrhenius behavior is observed, and the measured rate constants can be described by the expression k(T) = (1.9 ± 1.5) x 10^{-12} exp[-(0.88 ± 0.44 kcal mol^{-1})/RT] + (1.6 ± 0.7) x 10^{10} exp[-(5.7 ± 0.9 kcal mol^{-1})/RT] cm s$_1$, where the uncertainties represent ± 2σ. At room temperature the rate constant is pressure independent between 10 and 110 Torr total pressure (Ar buffer gas). Results are interpreted in terms of two metathesis reactions with different Arrhenius parameters, one yielding AlO and the other AlOH.

MCCLEAN, Roy E., Assistant Professor, and Mark L. CAMPBELL, Assistant Professor, "Kinetics of Neutral Transition-Metal Atoms in the Gas Phase: Oxidation Kinetics of Ti(^3F) from 300 to 600 K," *Journal of Physical Chemistry*, 97 (1993), 7942.

Gas-phase kinetics are reported for the reactions of Ti(a^3F) with O_2, N_2O, NO, CO_2, SO_2, and NO_2 from 300 to 600 K. Titanium atoms were produced by the photolysis of TiCl$_4$ at 248 nm and were detected by laser-induced fluorescence. Arrhenius expressions obtained for these reactions at a buffer gas pressure of 20 Torr are k(O_2) = (1.69 ± 0.41) x 10^{-10} exp[-(11.6 ± 0.8 kJ mol^{-1})/RT] cm^3 s^{-1}, k(N_2O) = (1.74 ± 0.44) x 10^{-10} exp[-(14.3 ± 0.9 kJ mol^{-1})/RT] cm^3 s^{-1}, k(NO) = (3.28 ± 0.69) x 10^{-11} exp[-(3.62 ± 0.71 kJ mol^{-1})/RT] cm^3 s^{-1}, k(CO_2) = (7.0 ± 1.6) x 10^{-11} exp[-(14.9 ± 0.8 kJ mol^{-1})/RT] cm^3 s^1, and k(SO_2) = (1.70 ± 0.33) x 10^{-10} exp[-(2.66 ± 0.64 kJ mol^{-1})/RT] cm^3 s^1. The rate constant of Ti with NO_2 was found to be temperature independent from 300 to 500 K with a value of (9 ± 4) x 10^{-11} cm^3 s . Quoted uncertainties are ± 2σ. With the exception of Ti + O_2, all reactions were investigated as a function of pressure. Only the reactions of Ti with NO and CO_2 were found to depend on the argon buffer gas pressure. Termolecular rate constants at 300 K were determined to be (5.8 ± 2.6) x 10^{-31} cm^6 s^{-1} and (3.5 ± 1.0) x 10^{-32} cm^6 s^{-1} for NO and CO_2, respectively.

Presentations

CAMPBELL, Mark L., Associate Professor, "Kinetics of Neutral Transition-Metal Atoms in the Gas Phase: Oxidation Reactions of Ti(a^3F) from 300 to 600 K," Third International Conference on Chemical Kinetics, Gaithersburg, Maryland, 13 July 1993.

CAMPBELL, Mark L., Associate Professor, "Reaction of Gas-Phase Metal Atoms,"The Catholic University of America, Washington, DC, 11 February 1994.

CHEEK, Graham T., Professor, "Electrochemistry of Aromatic Ketones in a Room-Temperature Molten Salt," 184th Electrochemical Society Meeting, New Orleans, Louisiana, 11 October 1993.

CHEEK, Graham T., Professor, "Quartz Crystal Microbalance Study of Platinum/Mercury Interactions," Gordon Conference, Ventura, California, 19 January 1994.

CHEEK, Graham T.,Professor, "Proton Donor Characteristics of a Room-Temperature Molten Salt,"

185th Electrochemical Society Meeting, San Francisco, California, 23 May 1994.

CHEEK, Graham T., Professor, "Study of Mercury Deposition on Platinum Using the Quartz Crystal Microbalance," 185th Electrochemical Society Meeting, San Francisco, California, 25 May 1994.

COREY, R. R., Professor, "British Strategy in the Chesapeake Bay during the War of 1812," Winter Lecture Series, Kent County Historical Society, Chestertown, Maryland, January 1994.

DILLNER, Debra K., Associate Professor, "Conformational Analysis and NMR Spectroscopy of Oxabicyclo[3.3.0]octanes," 207th American Chemical Society National Meeting, San Diego, California, 17 March 1994.

FERRANTE, Robert F., Associate Professor, co-author, "Laboratory Studies of Cometary Ice Analogs," National Aeronautics and Space Administration/Goddard Space

Flight Center, Greenbelt, Maryland, 9 July 1993.

FERRANTE, Robert F., Associate Professor, co-author, "Infrared Spectra of Crystalline Phase Ices Condensed on Silicate Smokes at T < 20 K," 25th Annual Meeting, American Astronomical Society, Division of Lunar and Planetary Sciences, Denver, Colorado, 22 October 1993.

FITZGERALD, Jeffrey P., Associate Professor, "A Sterically Hindered Tetraazaporphyrin: Synthesis, Characterization and Catalytic Properties," 206th American Chemical Society National Meeting, Chicago, Illinois, 22-27 August 1993.

FITZGERALD, Jeffrey P., Associate Professor, co-author, "Low Temperature Magnetism in Iron(II) Octaethyltetraazaporphyrin and Comparisons to Related Macrocycles," 207th American Chemical Society National Meeting, San Diego, California, 13-17 March 1994.

HARRISON, Judith A., Assistant Professor, "Atomic-Scale Friction and Wear of Diamond Surfaces," March meeting of the American Physical Society, Pittsburgh, Pennsylvania, 23 March 1994.

HARRISON, Judith A., Assistant Professor, "Investigation of the Atomic-Scale Friction and Wear of Diamond using Molecular Dynamics," International Conference on Metallurgical Coatings and Thin Films, San Diego, California, 25 April 1994.

HARRISON, Judith A., Assistant Professor, "The Atomic-Scale Investigation of Friction and Wear of Diamond Surfaces," Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 26 May 1994.

HEUER, William B., Assistant Professor, co-author, "Preparation and Characterization of Metal-Dithiocroconate Complexes," American Chemical Society National Meeting, San Diego, California, 13 March 1994.

HEUER, William B., Assistant Professor, co-author, "Intense Electronic Transitions: Polarizations from Specular Reflectance as a Spectroscopic Assignment Tool," American Chemical Society National Meeting, San Diego, California, 15 March 1994.

HEUER, William B., Assistant Professor, co-author, "Synthesis, Structure and Reactivity of Metal-Dithiocroconate Complexes," American Chemical

Society Mid-Atlantic Regional Meeting, Baltimore, Maryland, 25 May 1994.

LOMAX, Joseph F., Associate Professor, "Kinetic Classroom: Classroom Demonstrations with Student Movement," 207th American Chemical Society National Meeting, San Diego, California, 17 March 1994.

LOMAX, Joseph F., Associate Professor, "Conducting Midshipmen: A Demonstration of Charge Movement," 207th American Chemical Society National Meeting, San Diego, California, 15 March 1994.

LOMAX, Joseph F., Associate Professor and Wayne H. PEARSON, Assistant Professor, "Hf-β"-alumina: Synthesis, X-ray Crystal Structure and Dielectric Measurements," Mid-Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 26 May 1994.

MCCLEAN, Roy E., Assistant Professor, and Mark L. CAMPBELL, Assistant Professor, "Kinetics of Neutral Transition-Metal Atoms in the Gas Phase: Oxidation Kinetics of Ti(^{3}F) from 300 to 600 K," Third International Conference on Chemical Kinetics, Gaithersburg, Maryland, 12-16 July 1993.

PEARSON, Wayne H., Assistant Professor, co-author, "Preparation and Characterization of Metal-Dithiocroconate Complexes," 207th American Chemical Society National Meeting, San Diego, California, 13 March 1994.

PEARSON, Wayne H., Assistant Professor, co-author, "Synthesis and Structure of Hf-doped β"-Alumina," 28th Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 26 May 1994.

PEARSON, Wayne H., Assistant Professor, co-author, "Synthesis, Structure and Reactivity of Metal-Dithiocroconate Complexes," 28th Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 26 May 1994.

SHADE, Joyce E., Associate Professor, "Synthesis and Chemistry of Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls," 28th Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 25 May 1994.

SHADE, Joyce E., Associate Professor, Wayne H.PEARSON, Assistant Professor, and James E.BROWN, Midshipman 1/C, USN, "Photochemistry of $[CpM(CO)]_2$-u-DPPX, where DPPX = DPPM, DPPE or DPPP and M = Fe or Ru. An Unexpected Radical Reaction Route," Photochemistry Symposium at the 49th Northwest Regional Meeting of the American Chemical Society, Laramie, Wyoming, 18 June 1993.

SHADE, Joyce E., Associate Professor, Wayne H. PEARSON, Assistant Professor, and James E. BROWN, Midshipman 1/C, USN, "Photochemical Studies of $[(C_5H_5)M(CO)]_2$-u-DPPX in $CHCl$, where DPPX = DPPM, DPPE or DPPP and M = Fe or Ru," 1st Journal of Organometallic Chemistry Conference on Applied Organometallic Chemistry, Munich, Germany, 4-5 November 1993.

WAITE, Boyd A., Professor, "A Full Diffusion-Kinetics Model for Fiber Optics Immunosensor Assays," invited seminar at the Center for Biotechnology, Naval Research Laboratory, Washington, DC, 27 July 1993.

Computer Science

Commander Leroy G. Williams, USN
Chair

During the 1993-1994 academic year, the Computer Science Department continued to conduct important research and spread the Academy's name through publishing. The department encourages its faculty to seek summer support through outside funding. Last summer, the Naval Research Laboratory funded two faculty members. Other members were funded by the Defense Mapping Agency, the Naval Academy Research Committee (NARC), and the Minnesota Supercomputer Institute.

Student research continued to prosper. Dr. Andrew Phillips sponsored Midshipman 1/C Vann Walke's Trident Scholar project "Computational Solutions to the Protein Folding Problem". Another Trident proposal was accepted for study during the 1994-1995 Academic Year.

Considering the small number of civilian faculty, the Computer Science Department had an extremely productive year. Overall, there were twenty-three publications and fifteen presentations.

Sponsored Projects

Implementation and Application of a New Model of Communication for Distributed Computing Systems

Researcher: Assistant Professor Bryan Bayerdorffer
Sponser: Naval Academy Research Council (ONR)

Distributed computing is an active area of research in computer science. Distributed computing systems, which contain a number of processing elements that communicate via a network, have potential benefits in increased processing speed and robustness (correct operation in spite of partial failures of the system). It is difficult for program designers to effectively exploit the capabilities of distributed systems because of the inherent lack of information about the global state of the system at any instant. The fundamental challenge of distributed computing is to develop mechanisms that coordinate communication among the processing elements so as to allow high processing speed and/or robustness to be achieved while minimizing the effort expended in program design and maintenance.

This study's approach to the development of such mechanisms is twofold. The first element is the design of a new model of communication called Associative Broadcast that allows program designers to specify communication at a high level of abstraction. The primary contribution of Associative Broadcast is a naming system that is part of a distributed system which enables an active entity (e.g. a "process") to specify those other active entities with which it communicates. The second element of approach, and the next phase of this research, is to implement a prototype of Associative Broadcast for a particular distributed system, in order to enable specifications to be translated into executable programs.

Some Interesting Applications of Fractals

Researcher: Professor Frank L. K. Chi
Sponsor: Defense Mapping Agency

The study of fractals has, in the last decade, become a field of scientific interest. So far, researchers have determined limited applications of fractals in computer graphics and data compressions.

Both applications make use of the self-similarity property of fractals. Yet, there are other interesting properties of fractals which have not been explored. For example, the Hausdorff dimension is more appropriate than the topological dimension in describing fractals. Another interesting property of fractals is their dependency on scales.

This project explores these interesting properties of fractals, and attempts to identify possible new theoretical applications of fractals. Due to the importance but limited existing applications of fractals, it is reasonable to expect some interesting new applications will be identified.

High Parallel Case-Based Reasoning & Adaptive Planning

Researcher: Professor Patrick R. Harrison
Sponsor: Naval Research Laboratory

This program of research in Case-Based Reasoning (CBR) has three objectives: (1) Develop a strong theoretical basis for the design and implementation of a highly parallel, case-based reasoning and planning tool; (2) Implement and test tool components; (3) Integrate tool components into a development environment.

A sensor classification and clustering tool called Nearest Neighbor & Classification (NAC) has been developed and will be made available in June 1994. NAC can be used for Case Based Reasoning when the data set is flat, consisting of attribute value pairs and a training variable. Different similarity metrics, normalization procedures and adaptive critics can be experimented with to improve performance. NAC can also be used to model simple memory systems. NAC was developed on a SUN SPARC 10 and is being ported to Windows 3.1/DOS and the Connection Machine.

A Case-Based Reasoning environment called CART is also being prototyped. This is a large collection of tools to support the development and delivery of CBR systems. The first prototype is due for testing Spring 1995.

Data Fusion to Improve Computer Interfaces and Reduce CIC Communication

Researcher: Associate Professor Kay G. Schulze
Sponsor: Naval Research Laboratory

Even with the increase of computer technology available in the Fleet, verbal communications will always play a role in decision making in the Combat Information Center (CIC) arena. Studies have shown that communications are frequently a bottleneck in making real time decisions because, until now, communication has been the primary source of relaying interpreted information that has been transformed from raw data.

This research is attempting to use the technique of data fusion to automate some of the interpreted information and display it on the computer screen. If successful, this will help to reduce the amount of verbal communication, reduce the mental workload of individual team members and increase their situational awareness. This should provide a mechanism for studies that will help determine the information requirements for team decision making and test the theory that a computer knowledge base can be incorporated into the CIC team as a team communicator.

Independent Research

Computational Solutions to the Molecular Conformation Problem

Researcher: Associate Professor Andrew T. Phillips

In this research project conducted for the Minnesota Supercomputer Institute, the molecular conformation problem is formulated so that it can be solved by a two stage approach. The problem is first modeled by a discrete approximation on a 3-dimensional lattice. This discrete lattice model can be formulated as a quadratic assignment problem and then transformed into a continuous concave quadratic global minimization problem. The global solution to this concave minimization problem can then be used as a starting point for the second stage -- a "relaxed" continuous minimization problem. The result of this second stage should provide a global, or near global, minimum of the potential energy function, and hence a prediction of the native, or folded, state of the linear molecule. This two-stage approach has been used successfully to find the minimum energy conformation for very large problems based on a much simpler molecular model.

Enhancement of a Color Image Quantization

Researchers: Paula J. Reitan with Dr. W. D. Withers

Heckbert's algorithm for adaptive, tapered color image quantization is enhanced. The research is motivated by the desire to display color images with greater precision than is computationally feasible with Heckbert's algorithm. The color image quantization process is decomposed into fours steps:

(1) Sample the original image to create a histogram of its color distribution, (2) Select a colormap based on the color distribution of the original image, (3) Compute a quantization mapping from the colors in the image to the colors in the colormap, (4) Quantize and display each pixel in the original image.

The algorithm enhanced, Mean Volume Cut, is a variation of a color image quantization algorithm first described by Paul Heckbert. It uses a 3-dimensional array to store the histogram, requiring an array of size 2^{3p}, where p is the number of bits of color precision in each of the three color directions. For better running times, Heckbert suggests considering only the 5 high order bits of color precision when p>5.

This research shows that the color image quantization process can be significantly degraded by not considering all bits of color precision. The researchers propose a new algorithm which uses an AVL tree to store the histogram, thus enabling all bits of color precision to be used. This algorithm significantly reduces the quantization error of Mean Volume Cut with p=5. Our algorithm is significantly slower than Mean Volume Cut with p=5, but significantly faster than Mean Volume Cut with p=8.

Research Course Projects

Computational Solutions to the Protein Folding Problem

Researcher: Midshipmen 1/C Vann H. Walke, USN
Adviser: Associate Professor Andrew T. Phillips
Sponsors: Naval Academy Research Council (ONR) and Trident Scholar Program

This Trident Scholar research project involved the study of solution methods for the protein folding problem. The protein folding problem attempts to predict the native, or folded, state-of-a-protein in three-dimensional space, given its primary sequence of amino acids. One common approach for a solution is to treat each complex amino

acid as a single sphere, or "united atom," and to model each peptide linkage between residues by a virtual bond between spheres. Computational efforts being examined rely on two major assumptions: for any specific molecular conformation, a corresponding potential energy function can be computed, and the three-dimensional, folded state corresponds to the global minimum of this energy function. The optimization method being used to minimize the potential energy involves collecting a large number of conformers, each attained by finding a local minimum of the potential energy function from a random starting point. The information from these conformers is then used to form a convex quadratic global underestimating function for the potential energy of the known conformers. The minimum of this underestimator is used to predict the global minimum for the function, allowing a localized conformer search to be performed based on the predicted minimum. The new set of conformers generated by the localized search can serve as the basis for another quadratic underestimation. After several repetitions, the global minimum can be found with reasonable assurance. The conformer which lies at the global minimum represents the three-dimensional folded state-of-the-molecule.

Publications

BAYERDORFFER, Bryan, Assistant Professor, "Distributed Programming with Associative Broadcast," Proceedings 27th Artificial Intelligence Conference Systems Sciences, January, (1994), 353-362.

The author proposes a new model for distributed programming, called Associative Broadcast, that achieves a high level of communication abstraction by using as its fundamental mode of communication a form of logical broadcast. Each message contains a predicate that specifies the local states of the objects that are to receive the message, rather than their identifiers. Message delivery is a synchronous and requires no knowledge of the global state. Associative Broadcast exploits the broadcasting capabilities of distributed systems, and enables straightforward specification of state-based communication. The researchers use state-based communication to obtain a new solution to the partitioned-network consistency problem in distributed databases.

HARRISON, Patrick R., Professor, co-author, "Embedded Intelligent Sensor Control," *IEEE Expert Special Issue on Embedded Expert Systems*, (1994), 49-53.

This major paper details a theory of intelligent, real-time control and then shows how it was successfully applied to sensor control on a high speed aircraft.

HARRISON, Patrick R., Professor, co-author, "VEG: An Intelligent Workbench for Analyzing Spectral Reflectance Data," Proceedings of 1994 Goddard Conference on Space applications, of AI, Greenbelt, Maryland, (12 May 1994), 193-205.

This paper provides a conceptual overview of the VEG system. VEG is composed of a number of tools that are managed by a very sophisticated interface that has built in validation tools in the form of constraints on type, data range, data dependencies and data consistencies.

HARRISON, Patrick R., Professor, co-author, "Application of AI Techniques to Infer Vegetation Characteristics from Directional Reflectance(s)," Proceedings of Sixth International Symposium on Physical Measurement and Signatures in Remote Sensing, Val D'Isere, France, (19 January 1994), 581-592.

This paper focused on the Artificial Intelligent aspects of the VEG system.

HARRISON, Patrick R., Professor, co-author, "Practical Issues in the Development of an Embedded Real-Time Expert System," Proceedings of the Second World Congress on Expert Systems, Lisbon, Portugal, (12 January 1994), 393-399.

This paper details important theoretical and practical issues developing real-time applications. It also discusses the important issue of building testbeds for the testing of systems.

HARRISON, Patrick R., Professor, co-author, "Memory Organization for Case Based Reasoning," Proceedings of the Second World Congress on Expert Systems, Lisbon, Portugal, (12 January 1994), 311-316.

This paper details a theory of memory that has provided a basis for the design of heuristically adequate, computationally efficient and cognitively plausible Case

Based Reasoning Systems.

HARRISON, Patrick R., Professor, co-author, "Case-Based Sonogram Classification," Naval Research Laboratory Technical Report NRL/FR/5510-94-9707, (January 1994).

This paper replicates and extends results reported by NAWC personnel on the automatic classification of sonar images. Classifiers from the Machine Learning literature were tested and shown to be superior to the techniques used at NAWC. The report also describes several ways to incorporate domain-specific knowledge to these kinds of tasks.

PARK, Eun K., Associate Professor, co-author, "Object-Oriented Database Design Methodologies: A Survey," *Lectures Notes Series in Computer Science*, Vol. 752, Springer Verlag, (November 1993), 115-142.

This paper surveys the various methods and tools proposed for an object-oriented database (OODB) schema design. An extensive survey of current literature in this area indicates that structural aspects of OODB are modeled separately from their dynamic behaviors. Even though some of them discuss both at the same time, they merely present either a specification language or notation to impose the operations onto the structure. Hence, this project classifies methodologies into two categories: first, by their structure and behavior modeling; secondly, by the way relationships are handled. This survey will help to identify strengths and weaknesses of individual methodologies, as well as general guidelines for future improvements and extension of methods and tools. Lastly, a summary of research issues for OODB schema design is given.

PARK, Eun K., Associate Professor, co-author, Extensions to the C Programming Language for Enhanced Failure Detection," *Journal of software - Practice and Experience*, Vol. 12 (6), John Wiley and Sons, Ltd., (June 1993), 617-628.

The acceptance of the C programming language by academia and industry is partially responsible for the 'software crisis'. The simple, trusting semantics of C masks many common faults, such as range violations, which would be detected and reported at run-time by programs coded in a robust language such as Ada.* This needlessly complicates the debugging of C programs. Although the assert macro lets programmers add run-time consistency checks to their programs, the number of instantiations of this macro needed to make a C program

robust makes it highly unlikely that any programmer could correctly perform the task. Unobtrusive extensions are made to the C language which support the efficient detection of faults at run-time without reducing the readability of the source code, Examples of the extensions are automatic checking of error codes returned by library routines, constrained subtypes, and detection of references to uninitialized and/or non-existent array elements.

PARK, Eun K., Associate Professor, co-author, "Intelligent Tools for System Analysis and Design," *Journal of Software Engineering Strategy*, Auerback Publications, New York. (January/February 1994), 49-57.

During the past few years, the use of expert systems has been increasingly integrated into systems analysis and design activities, resulting in higher-quality and more efficient processes. These expert systems' tools guide design input, create interfaces with other analysis and implementation tools, and to some extent, validate designs. The main reason for using expert systems in analysis and design has been to relieve the work load of systems analysts. Traditional CASE tools have done little more than provide a means for creating graphical diagrams that are dependent wholly on the input and knowledge of the analyst.

This article gives an overview of the intelligent systems that support the process of systems analysis and design. Some of these tools are in use and the others are currently being developed. Object-oriented tools, ALESCI and SPADE, are examined in the next section. ALESCI is a modeling expert system meant to support requirements acquisition and analysis. Used for design, SPADE assists in maximizing the reusability of software components.

Expert systems can be used not only to automate the analysis and design process, but also as an integral part of the system's design process. As this article shows, intelligent systems can be an element in temporal data bases. Such data bases can bridge the gap between design specifications and execution specifications.

An approach to the design of composite systems is also presented. Composite systems integrate software, hardware, and human agents to solve applications problems. In the approach discussed in this article, an interactive design tool and methodology is used for producing composite systems.

Intelligent tools that automate every stage of systems and software development are currently being produced. Some of these projects as well as future issues and research directions in the use of expert systems for

analysis and design are also examined.

PARK, Eun K., Associate Professor, co-author, "Checkpointing and Rollback Recovery Algorithms in Distributed Systems," *Journal of Systems and Software*, 15, 1 (1994) 59-71.

To keep the system free from arbitrary failures, a distributed system may require taking checkpoints from time to time. In case of failures, the system will rollback to checkpoints where global consistency is preserved. The concept of global consistency defined in this paper eliminates both received-not-sent and sent-not-received types of inconsistencies. The researchers developed synchronous checkpoint algorithm C* and synchronous rollback recovering algorithm R* with O(VE) message complexity which has a relatively small coefficient, where V is the number of processors and E is the number of communication links in the system. Neither incoming message logging nor message number calculation is needed. The algorithms work well in complicated situations like communication loops involving a minimal number of processors. Due to the feature of instant crash recovery and the overall low time, space and message complexities, these algorithms are most feasible in real-time applications where rapid rollback recovery is crucial.

PARK, Eun K., Associate Professor, co-author, "Towards the Design and Development of a new Architecture for Geographic Informations Systems," Proceedings of ACM Conference on Information and Knowledge Management CIK93), (1-5 November 1993), 565-573.

Existing geographic information systems lack many important features such as the ability to model the real world more adequately and facilities for logical deduction and geometric computation. This paper studies the structure and behavior of existing geographic information systems, isolates their drawbacks, and explores the applicability of object-oriented design, logical deduction and hypermedia to develop better and more efficient geographic information systems. The paper focuses on the concept, design and development of an architecture for the next generation geographic information systems, which will be able to access, synthesize and reason large volumes of geographic information more efficiently and effectively, without sacrificing functionality, extensibility and consistency. Of significance is the integration of diverse forms of technological advancements, including object oriented design, expert systems and multi-media systems.

PARK, Eun K., Associate Professor, co-author, "Binary Relationship Imposition Rules on Ternary Relationships in ER Modeling," Proceedings of ACM Conference on Information and Knowledge Management (CIKM93), (1-5 November 1993), 57-66.

This paper discusses the simultaneous existence, and relationship between binary and ternary structures. The researchers demonstrate which binary relationship cardinalities are permitted within ternary relationships during ER modeling. They develop an Implicit Binary Cardinality rule (IBC rule), which states that, in any ternary relationship, the cardinality of any binary relationship embedded in the ternary, is many-to-many when there are no explicit constraints on the data instances. Then a presentation of an Explicit Binary Permission rule (EBP rule), which explains and enumerates all permitted binary relationships for various cardinalities of ternary relationships is given. Finally, the researchers present an Implicit Binary Override rule (IBO rule), which states that the implicit binary cardinalities can be constrained in a ternary relationship by explicit constraints imposed by a binary relationship. The paper also details how the cardinalities within the ternary are altered as the binary relationship is imposed.

In discussing these findings, the researchers consider the rules in the context of decomposing ternary relationships into multiple binary relationships.

PARK, Eun K., Associate Professor, co-author, "An Analytical Model for the Binary Feedback Scheme," Proceedings of Conference on MASCOTS '94, Sponsored by ACM and IEEE, Durham, North Carolina. (January 1994), 263-267.

An analytical model is developed for performance evaluation of the binary feedback scheme for congestion control in data communication networks. The relationship between the change of window size and the length of the source queue is discovered by introducing an auxiliary virtual packet blocking mechanism. Based on this relationship it is demonstrated that the system throughout can be computed locally by monitoring the traffic in the source node. The model is solved by a new mean value analysis algorithm. The significance of this study is the provision of a uniform modeling approach which can be generally applied to other feedback control mechanisms. Finally, numerical examples are given to demonstrate the methodology and the validity of the analytical results.

PARK, Eun K., Associate Professor, "Augmented Priority Ceiling Protocol: Task Synchronization for Preemptive Real-Time Systems," Proceedings of ACM CSC'94, Phoenix, Arizona, (March 1994), 1-6.

In a preemptive priority-driven real-time system, tasks frequently share data and non-preemptable resources. Some common synchronization primitives such as semaphores, monitors, or the Ada rendezvous can be used to maintain data consistency. However, a direct application of these synchronization mechanisms may lead to uncontrolled priority inversion, deadlock formation, and chained blocking. The researcher developed the augmented priority ceiling protocol to address these problems. This paper demonstrates that this protocol eliminates the above three problems effectively. A compared of the algorithm with the priority ceiling protocol showed that the algorithm reduces unnecessary blocking, but at the expense of some overhead.

PHILLIPS, Andrew T., Associate Professor, co-author, "A Quadratic Assignment Formulation of the Molecular Conformation Problem," *Journal of Global Optimization*: 4 (1994), 229-241.

The molecular conformation problem is formulated so that it can be solved by a two stage approach. The problem is first modeled by a discrete approximation of a 3-dimensional lattice. This discrete lattice model can be formulated as a quadratic assignment problem and then transformed into a continuous concave quadratic global minimization problem. The global solution to this concave minimization problem can then be used as starting point for the second stage--a "relaxed" continuous minimization problem. The result of this second stage should provide a global, or near global, minimum of the potential energy function, and hence a prediction of the native, or folded, state of the linear molecule. This two-stage approach has been used successfully to find the minimum energy conformation for very large problems based on a much simpler molecular model.

SCHULZE, Kay G., Associate Professor, co-author,"Performance Issues and Analysis of Brevity Code Usage in AEGIS Communications," NRL/FR/5522-93-9573, (December 1993).

Communications are a crucial aspect of military decision making. In the AEGIS Combat Information Center (CIC) context, verbal communication and the use of computerized combat systems and computerized displays interact to produce effective team performance. The researchers recorded internal CIC communications during AEGIS team training exercises and developed a classification scheme to categorize each communication. The team communications were coded and analyzed at the speech turn level, with emphasis on the distinctions between speech turns that included the use of brevity codes and those that did not. For a single team from early to late training, changes in communication patterns were used to investigate hypotheses about effective communication.

Significant changes observed with increased training included more brevity code words used and more format violations in brevity code speech turns than expected. The use of interpreted information also significantly increased with training and was significantly more frequent in brevity code speech turns than in the transcripts in general. The repetition and error classifications show no consistent trends.

The Tactical Action Officer carries the heaviest communication workload and receives the most interpreted information while producing a very few of the interpreted information speech turns. By comparing speaker and receiver workload, an information distribution hierarchy for AEGIS teams can be interpreted in the context of cognitive task analysis.

The results have implications for planning training strategies and evaluation methods, including performance feedback and specialized training tailored to the needs of individual team members.

SCHULZE, Kay G., Associate Professor, co-author, "Brevity Code Frequencies in AEGIS Team Training Communications," NRL/FR/5522-93-9574, (1994).

Communications are a crucial aspect of military decision making. NATO restricted brevity codes are often used in verbal communications of AEGIS team members during training sessions and in the Fleet. An understanding of the relationship between brevity code use and communication performance during AEGIS team training is important for brevity code training issues. The researchers recorded the internal Combat Information Center (CIC) communications during AEGIS team training exercises and performed an analysis on speech turns that contained brevity codes.

Brevity codes were identified, categorized, and analyzed and on average, 58% of the brevity codes were used as defined. The remaining were used consistently as ordinary English or in a manner designated as "Professional." Brevity codes were categorized as Professional if they were used in a consistent manner by team members in what appeared to be a mutually accepted and consistent meaning different from either

NATO or English meanings.

Presentations

BAYERDORFFER, Bryan, Assistant Professor, "Distributed Programming with Associative Broadcast", 28th HI International Conference Systems Sciences, Wailea, Hawaii, 6 January, 1994.

CHI, L.K., Professor, "Fractals and Cosmology," Computer Science Department, U.S. Naval Academy, 28 February, 1994.

HARRISON, Patrick R., Professor, co-author, VEG: "An Intelligence Workbench for Analyzing Spectral Reflectance Data. 1994 Goddard Conference on Space Applications of AI, Greenbelt, Maryland, 12 May, 1994.

HARRISON, Patrick R., Professor, co-author, "Application of AI Techniques to Infer Vegetation Characteristics from Directional Reflectance(s). Sixth International Symposium on Physical Measurements and Signatures in Remote Sensing," Val D'Isere, France, 19 January, 1994.

HARRISON, Patrick R., Professor, co-author, "Practical Issues in the Development of an Embedded Real-Time Expert System," Second World Congress on Expert Systems, Lisbon, Portugal, 12 January, 1994.

HARRISON, Patrick R., Professor, co-author, "Memory Organization for Case Based Reasoning," Proceedings of the Second World Congress on Expert Systems, Lisbon, Portugal, 12 January , 1994.

HARRISON, Patrick R., Professor, co-author, "Parallel Cased-Based Reasoning & Planning," Internal Seminar, NRL, Center for Applied Research in Artificial Intelligence, Summer, 1993.

NEEDHAM, Donald M., Lieutenant Commander, USN, "The Use of Ada in Academic," Ada Dual-Use Workshop, Vienna, Virginia, 19-20 November, 1993.

PARK, Eun K., Associate Professor, "Augmental Priority Ceiling Protocol: task Synchronization for Preemptive Real-Time Systems," ACM Computer Science Conference (ACM/CSC94), Phoenix, Arizona, 7-10 March, 1994.

PARK, Eun K., Associate Professor, "Towards the Design and Development of a New Architecture for Geographic Information Systems," ACM Conference on Information and Knowledge Management (CIKM93), Alexandria, Virginia, 1-5 November, 1993.

PARK, Eun K., Associate Professor, "Binary Relationship Imposition Rules on Ternary Relationships in ER Modeling," ACM Conference on Information and Knowledge Management (CIKM93), Alexandria, Virginia, 1-5 November , 1993.

PARK, Eun K., Associate Professor, "Data Communication Algorithms for a Generalized Z-cube Inter-Connection Network," ACM/ISCA International Conference on Computer Communications and Networks (ICCCN93), San Diego, California, 28-30 June, 1993.

PHILLIPS, Andrew T., Associate Professor, "An Optimization Approach to the Molecular Conformation Problem". ORSA/TIMS Joint National Meeting, Boston, Massachusetts, 27 April, 1994.

PHILLIPS, Andrew T., Associate Professor, "Protein Folding by Discrete Global Minimization," ORSA/TIMS Joint National Meeting, Phoenix, Arizona, 1 November, 1993.

SCHULZE, Kay G., Associate Professor, co-author, "An Analysis of AEGIS Team Member Communication Workload and Team Coordination," 3 7th Annual Meeting of the Human Factors and Ergonomics Societies, Seattle, Washington, October, 1993.

Mathematics

Professor James M. D'Archangelo
Chair

Mathematics provides a logical framework and a language indispensable to understanding the world in which we live. The following pages summarize the many contributions to this field of study made during the past year by the faculty and students of the Naval Academy. The results cited reveal the great scope and diversity of mathematics and offer glimpses of its intellectual beauty and appeal.

Five midshipmen, participating either in the Honors Mathematics Major or in special research project courses, teamed up with faculty advisers to apply their mathematical skills to a variety of interesting problems. For example, Midshipman Thomas H. Hayghe worked with Professor Thomas J. Sanders and Major Pete F. Long determining if artificial neural networks could be used to build a mathematical model that would be useful in predicting the performance of the Marine Corps' Second Lieutenants at The Basic School. Midshipman Patrick M. Burger worked with Associate Professor Jody M. Lockhart in studying the algebraic topic of crystallographic groups and illustrating them with the works of the graphic artist M. C. Esher.

This past academic year was again a very productive one for the faculty. Twenty-three research articles appeared in refereed journals published throughout the United States and abroad. The topics covered in these articles are as varied as mathematics itself. They range from the "applied" areas of submarine detection, optimizing ship berthing, and the fracturing of ice formations, to the "pure" areas of harmonic functions, C*-algebras, and number theory.

Over forty research projects were conducted by members of the Mathematics Department with the support of a variety of sources such as the National Science Foundation, the Johns Hopkins University Applied Physics Laboratory, the Naval Air Warfare Center, the Naval Academy Research Council, the Naval Ship Warfare Center, the Naval Academy Instructional Development Advisory Committee, the Office of the Chief of Naval Research, the Naval Research Laboratory, and the National Security Agency.

During the past year, department members presented the results of their work on fifty-eight different occasions at professional mathematical meetings and colloquia throughout the United States and abroad. This activity, along with publication, enhances the academic stature of the Naval Academy and promotes the professional growth and reputation of those individuals involved. Through research activity, the faculty learn of and take part in the discovery of new mathematics. This new material and ideas can then be shared with midshipmen in advanced courses.

Sponsored Research

Submarine Tactics in a Sporadic Active Sonobuoy Field

Researcher: Professor P. Peter Andre
Sponsor: Johns Hopkins Applied Physics Laboratory

A sporadic active sonobuoy field allows the attacker to locate a quiet target submarine when the target is known to be a large search area. The sporadic nature of the pinging allows the attacker to search over a large area and to find acoustic evidence of the target at any of the sonobuoys not only at the sonobuoy which generated the ping. The only evidence available to a submarine hunted by such a sonobuoy field is the set of bearings to the sonobuoys that have been activated. From this meager set of data, the submarine must determine a tactic which will attempt to minimize the chance of detection before the lifetime of the sonobuoy field expires. The tactic must balance the interest in escaping the field with the desire to have a bow-stern aspect toward each future ping. The goal of this project was to create an optimal tactic for the targeted submarine.

MATHEMATICS

Rank Determination for a Noisy Matrix

Researcher: Professor Michael W. Chamberlain
Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

The Navy uses (e.g., in acoustics and radar) electronic devices which deliver signals that can be represented as relatively small dense matrices of numbers. The status of such a device is in part contained in the rank of this matrix. However, due to "noise" inherent both within the device and in the transmission of the signal, the observed matrix arrives in an altered form which typically has a different rank. Several researchers have put forth rank determination algorithms that attempt to reconstruct the true rank.

Graph-Matching Neural Networks for Fingerprint Identification

Researcher: Professor Carol G. Crawford
Sponsor: Office of Naval Research

This ongoing investigation applies techniques and theories of graph theory to the design of graph-matching neural networks for automated fingerprint identification. In particular, this work utilizes generalized sphere-of-influence graphs to represent fingerprint minutia maps. This work has been part of a cooperative effort with Eric Mjolsness and the Center for Theoretical and Applied Neural Science (CTAN) at Yale University. This research is an outgrowth of a prior investigation for the Federal Bureau of Investigation as reported in "Automated Fingerprint Identification: An Independent Study," 1991, and "Graph-Matching and Image Processing Neural Networks for Fingerprint Identification," 1992. The current investigation focuses on matching and classification of fingerprints.

Critical Features for Aircraft Classification

Researcher: Professor Carol G. Crawford
Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

The major effort of this project was to determine critical features for developing a single-target, multiple-source aircraft identification/classification system that takes advantage of many sensor and non-sensor inputs. In particular, this research explored algorithms for determining optimal feature selection and extraction, including nearest neighbor algorithms and innovative graph representations for clustering techniques. The objective of this project with NAWC, Warminster PA, was to build a better rank determinator that is based on relatively simple mathematical concepts which could possibly be implemented in microcircuitry. A specific goal was to improve upon the results described in the paper, "Statistical Analysis of Effective Singular Values in Matrix Rank Determination," Konstantinides and Yao, *IEEE Transactions of Acoustics, Speech, and Signal Processing,* 36, 5, May 1988.

Closed-loop Degaussing Using Moment Correlation with a Physical Model

Researcher: Associate Professor Gary Fowler
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Degaussing a ship means to reduce (to zero) the magnetic signature of the ship. This makes it less vulnerable to detection. Degaussing is accomplished by running the correct electrical current through coils onboard the ship. Closed-loop refers to the technique of using onboard sensors to determine the correct coil currents. A closed-loop degaussing algorithm using moment correlation has been developed by researchers at the Academy and NSWC-Annapolis. This classified research and report

evaluates the effectiveness of this algorithm on a scale model of a ship.

Some Observations on Raviart-Thomas Mixed Finite Element Method in the p-Extension for Parabolic Equations

Researcher: Assistant Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research

The researcher investigates a parabolic problem from the point of view of stability and approximation properties of increasing order (in space) finite element methods. Previous estimates for the Raviart-Thomas projection are proven to be sharp. The researcher analyses the effects of the mixed finite element discretization in space to present transient error estimates for semidiscrete mixed finite element methods.

Modified Saper Metrics and Singular Algebraic Varieties

Researcher: Associate Professor Caroline G. Grant
Sponsor: Naval Academy Research Council (OMN)

Kahler metrics with appropriate growth conditions on the nonsingular set of a complex algebraic variety are useful in describing the geometry of the variety. The author, in joint work with Prof. P. Milman of the University of Toronto, has shown that each singular algebraic variety X has a complete Kahler metric with the desired growth conditions and of a particularly simple form. Essentially, this is the sum of an incomplete metric induced from an embedding of X in projective space, and a Poincare-type form with a generating function f which is C_∞ on X and vanishes on the singular locus of X. They also show that there is a procedure for constructing such a function f explicitly, locally near any singular point of X, as a sum of the squares of the magnitudes of local holomorphic functions which vanish on the singular locus. They show by example that such functions are often easy to construct and may be more convenient for describing the geometry of X than a sequence of blow-up maps which resolves the singularities. A paper on these results is in preparation.

The Einstein Gravitational Field and Ultrasmooth Microeffects

Researcher: Professor Robert A. Herrmann
Sponsor: Naval Academy Research Council (OMN)

In recent years, it has been amply demonstrated that the basic derivations for the conclusions of both the Special and General Theories of Relativity contradict the formal rules for mathematical model construction. A new derivation for the Special Theory that predicts all of its conclusions was devised previously. That derivation eliminated all model-theoretic errors as well as all controversial concepts such as universal time dilation and length contraction. The General Theory suffered from the same logical errors as did the Special Theory. The objective of this project is to construct a new derivation for all of the verifiable conclusions of the General Theory of Relativity that will eliminate all of the model-theoretic logical errors and any controversial philosophical notions. This derivation has been obtained and the project is completed.

Stability of Spacetimes with Mild Singularities or Cauchy Horizons

Researcher: Associate Professor Deborah A. Konkowski
Sponsor: National Science Foundation

The researcher is studying mild singularities and Cauchy horizons in spacetime models. Mild singularities include quasiregular and nonscalar curvature singularities. In the former, particle paths may end with no accompanying physical catastrophes, while in the latter, some particles moving near the singularity will feel infinite tidal forces, but not all do. In most cases, the spacetime models examined satisfy Einstein's equations.

In particular, the researcher is using a conjecture proposed in her thesis and published with T. M. Helliwell in 1985 to predict whether various mild singularities and Cauchy horizons are stable. Thus far the conjecture has held true for the quasiregular singularities in Taub-NUY-type cosmologies and in Khan-Penrose spacetime when fields are added. When applied to the quasiregular singularity in Bill-Szekeres spacetime and the Cauchy horizon and nonscalar curvature singularity in a Type V LRS spacetime, a prediction was possible but no exact spacetimes were available for comparison. A study of the Cauchy horizons in the Reissner-Nordstrom spacetime using the conjecture accurately predicted the effects of null dust when compared with exact solutions. This year, the conjecture was used to study the stability of the Cauchy horizons in the Kerr spacetime. The horizons were found to be unstable to the formation of nonscalar and scalar curvature singularities.

The researcher plans to continue to use the conjecture in a funded NSF project to study the structure of the singularities and Cauchy horizons in anti-deSitter spacetime, a pathological spacetime constructed by Geroch, plane-wave-cosmo string spacetimes, global cosmic string models, tilted Class B Bianchi cosmologies with whimpers and certain spherically symmetric dust shell model with quasiregular singularities. She also plans to test the conjecture using spacetimes with Weyl curvature singularities.

The Conjugacy Problem for Graph Products

Researcher: Associate Professor Jody M. Lockhart
Sponsor: Naval Academy Research Council (OMN)

The conjugacy problem for graph products over graphs with a single vertex, with infinitely many edges and with cyclic edge groups whose images are central in their vertex groups has recently been studied by Horadam and Farr. In this case the graph product is an HNN-extension of the form

$$< G, t_i, i \in I; t_i^{-1} x^{k_i} t_i = x^{l_i}, k_i, l_i \in Z, i \in I >$$

Horadam and Farr have shown the solvability of the conjugacy problem to be preserved in several cases. In particular, it is preserved (i) when $k^i = l_i$ for all i; (ii) when cd $(k_i l_j, k_j l_i) = 1$ for $i \neq j$; and (iii) when there is $\beta \in N$ such that k_i and l_i are powers of β for all i .

In this project, the results of Horadam and Farr were extended in several ways. The researcher considered graphs of groups where the graph has more than one vertex and the edge groups are infinite cyclic and with edge labels (k_i, l_i). When condition (i) or (iii) is met, the analogous result is still valid for graphs with a finite number of vertices. When condition (ii) is met, a similar result is valid for graphs with finitely or infinitely many vertices. Condition (iii) itself can be weakened; if there exist finitely many prime numbers such that the prime divisors of the k_i and l_i (for all i) are included in this finite list of primes, then the analogous result is valid.

Symmetry and Multiple Eigenvalues of Laplacians

Researcher: Associate Professor Robert Lockhart
Sponsor: Naval Academy Research Council (OMN)

Frequently in problems in mathematical physics or engineering one has to consider the eigenvalues of a Laplacian on a compact manifold. For instance, the problem of a vibrating drum head involves the eigenvalues of the Dirichlet Laplacian defined on the compact manifold with a boundary that forms the drum head. One of the properties of these eigenvalues that one is interested in is whether or not any of them are multiple. Since it is usually impossible to compute them explicitly, it would seem that this is not something that could be known too often. Nevertheless, in NARC funded research, the researcher was able to show that there is a simple geometric criterion for the existence of infinitely many multiple eigenvalues. Namely, if the compact manifold admits a symmetry of order 3 or more, then infinitely many of the eigenvalues are multiple. Since

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finding this result, the researcher has been trying to see if the existence of multiple eigenvalues implies the existence of a non-trivial symmetry.

Stability, Bifurcation and Fracture in Ice Mechanics

Researcher: Professor Reza Malek-Madani
Sponsor: Office of Naval Research

This proposal concerns three sets of partial differential equations that model the formation of wing cracks in ice, flow of ice-ocean fluid in the Arctic region, and the influence of Arctic ocean internal wave packets on ice flexure.

The first set of differential equations will model a block of ice under uniaxial compression. Ice will be modelled as an anisotropic thermally conducting material with a nonlinear constitutive law. Using the three dimensional formulation of the problem, the formation of wing cracks as a primary-secondary bifurcation problem will be established. The stability of wing cracks as equilibrium solutions of the governing equations will be one of the goals of this part of the proposal. Another goal of this work will be to compare the critical values of the loads that trigger the onset of wing crack formation with the available data of the experimental work of E. Schulson., or the second set of equations the main points of concern are the existence of global weak solutions for the kind of nonlinearities that model ice deformation as a

compressible visco-plastic material. These equations of motion have been introduced by W. D. Hibler and have received some analytical and numerical treatments in the past. Because the flow is two dimensional, recent results on quasilinear parabolic systems will be used to extract the existence theorem. Then, in order to resolve a question concerning the localization of the flow near coastal boundaries, steady-state solutions of the system will be studied in a circular domain. The solutions will be cast as minimizers of proper nonlinear functionals and their stability as solutions of the full dynamical system will be established.

The third set of equations were motivated by the experimental results of measurements of ice tilt during the Coordinated Eastern Arctic Experiment (CEAREX) and the ensuing discovery of internal waves on the Yermak plateau. The purpose of this part of the proposal is to develop a mathematical model for the experimental work and prove the existence of solitary waves for this model.

Fractal Structure of Radar Sea and Rain Scatter

Researcher: Professor Mark D. Meyerson
Sponsor: Naval Research Laboratory

Investigation proceeded on two fronts. Data provided by NRL was tested for evidence of a low dimensional attractor. Of particular interest is a comparison of in-

phase and quadrature channel data. Also, techniques to predict data from an initial string of data were tested.

Computing Gröbner Bases over the Integers

Researchers: Associate Professor George Nakos and Nikolaos Glinos
Sponsor: Naval Academy Research Council (OMN)

Gröbner bases were introduced by Bruno Buchberger in his thesis to solve systems of algebraic equations. Since then, they have come to play an important role in a wide variety of disciplines, such as computer algebra, computational commutative algebra, and algebraic geometry. Today, all symbolic mathematical packages use Gröbner bases to solve algebraic systems of equations and many provide routines that compute Gröbner bases in polynomial rings over fields. Major

application areas of Gröbner bases include canonical simplification in polynomial rings, computations of ideal membership and primary decomposition, residue class ring multiplications, and simplifications of radical expressions.

The authors wrote a *Mathematica* implementation of Buchberger's algorithm for computing Gröbner bases over the integers. The manuscript includes some background on Gröbner bases followed by discussions of

the algorithm and the implementation. The program computes what are known as reduced strong Gröbner bases over the integers. The resulting paper will appear in the summer issue of the *Mathematica Journal*.

Extensive details with many new examples will appear in a lengthy technical report submitted to the Mathematics Department of the University of Ioannina, Greece.

A Prescience Course

Researchers: Professor Howard L. Penn (Mathematics), Lieutenant Commander Chuck Edmonson, USN (Physics), and Associate Professors Kay Schultz (Computer Science), Joyce Shade (Chemistry)
Sponsor: Naval Academy Instructional Development Program

The purpose of this project was to develop a prescience course for those students who are deficient in their science and mathematics background. Every year a small number of Midshipmen come to the Naval Academy whose background in Science and Mathematics is so weak that they struggle with their Chemistry, Physics, Electrical Engineering, and Systems Engineering Courses. The purpose of this project is to develop a course to help bring these students up to speed so that they may succeed in these courses.

During the Spring of 1993, it was proposed to the Core Curriculum Committee that there should be a Pre-Science Course that would fulfil the same purpose that SM005 does for students who are weak in Mathematics. The Committee agreed with this proposal as did all the other committees up the chain of command. The group of four investigators was formed to oversee the formation of this course. During the Summer of 1993, the committee met several times to put the course together and develop methods to select the students. The primary selection criteria was the Midshipmen's performance on the standardized Toledo Exam. This exam has three parts. The first was basic Mathematic skills. The second was general Science knowledge and the third was more specific knowledge of Chemistry. Many other factors were also used. These included high school grades, SAT

scores, scores on the Mathematics Department Placement Exam and the admissions records. Thirty-seven students were selected for the course. The materials to be used would draw on examples from Physics and Chemistry and would include instruction on the use of the Computer. The emphasis of the course was on building skills not on learning specific topics. Joyce Shade was selected to teach the two sections with help from LCDR Kaplan from the Computer Science Department. The course, SY100 was taught in the Fall of 1993.

The students have now completed the course as well as the first semester of Chemistry. Their grades in Chemistry I will be compared with those of the students who failed Chemistry I in the Fall. The students will then take Chemistry II in Summer School and will then take Physics in 1994-95. Their grades in these courses will be compared with a control group that was identified for comparison. It will be at least another year before the researchers can fully assess the success or failure of the course.

The same committee has been formed to oversee the course for 1994-95. At this time the researchers plan not to change much in the selection criteria or the method the course is to be taught.

Cores for Unbounded Operators

Researcher: Professor Geoffrey L. Price
Sponsors: National Science Foundation
and National Security Agency

An unbounded operator S on a Hilbert space $\hbar$ is called symmetric, or formally self-adjoint, if the domain $D(S)$ of S is a dense linear subspace of $\hbar$ and if $(Sx,y) = (x,Sy)$ for all elements x,y of $D(S)$. In past work with P. Jorgensen, the researcher has considered the problem of determining whether $D(S) \otimes D(S)$ is a core for the domain of the operator $S\hbar I + I\hbar S$ on the tensor product space. The authors have generalized this work to show that for any

formally normal operator N on $\hbar$, $N\hbar I + I\hbar N$ has $D(N)\hbar D(N)$ as a core for its domain. This work has useful applications as a technical tool in the study of the second quantization of unbounded operators on Fock space. A current investigation is underway to determine whether the core property is true for all densely defined unbounded operators on a Hilbert space. The authors

suspect that the property is not true in general and hope to find a way of determining the obstruction.

Shifts on Factors

Researcher: Professor Geoffrey L. Price
Sponsors: National Science Foundation and National Security Agency

One of the key problems in the theory of von Neumann algebras is to study and to classify the position of subfactors of a prescribed index in the hyperfinite II_1 factor. In many ways this problem resembles the analysis of subgroups in group theory; the group theoretic notions of index, normality, and conjugacy all have analogues in the index theory for subfactors. Over the past few years Price has worked jointly with R. T. Powers to study a family of subfactors in the hyperfinite II_1 factor on which one can define a sort of non-commutative bernoulli shift of index 2. For each factor in this family there is a corresponding bitstream of O's and 1's which determines the behavior of the shift. The structure of the bitstream is reflected by certain properties possessed by the shift. Using computer programs written by the authors to analyze the structure of the bitstreams, the authors have collected evidence suggesting that all binary shifts of commutant index 2 are cocycle conjugate. They have also succeeded in computing the entropy of binary shifts in a number of cases. This has led to the conjecture, proved in the lower index cases, that any shift with a finite commutant index must contain a copy of a binary shift. Part of this research has just appeared in a journal.

Cruise Missile/TACAIR Effectiveness Assessment Software

Researcher: Professor Thomas J. Sanders
Sponsor: The Johns Hopkins University Applied Physics Laboratory

This project involved the continued development of a cruise missile and tactical air (TACAIR) effectiveness assessment system that is being done by the Strike and Anti-Surface Warfare Group of the Naval Warfare Analysis Department of the Johns Hopkins University Applied Physics Laboratory (APL). The purpose of this system is to aid an analyst in scenario development, scenario analysis, survivability analysis, mission planning, and equipment performance prediction. During the summer of 1993, this investigator added options and improved the DTED map program (DTMA). This program is expected to become a part of the user interface of the group's Integrated Air Defense System (IADS) simulation. The DTMA program was written in C++ and MacApp, and may be used by an analyst to display and manipulate Digital Terrain Elevation Data (DTED) files.

The DTED files are data files generated by the Defense Mapping Agency and are used in aspects of cruise missile mission planning. In particular, they are used by an analyst to assist in scenario analysis to investigate such things as radar site location and masking, and cruise missile flight paths. The DTED map program developed allows for computer generated color displays of the (large) data files quickly, allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths.

The IADS program is being developed to provide a simulation model that can be used in survivability and effectiveness studies of strikes against an integrated air defense system. The interface that the investigator began developing will provide an analyst with a tool to set up a scenario to be studied and will facilitate the placement of radar sites, vehicle (cruise missiles and/or aircraft) routes, target locations, command centers, etc. It will also use the DTED data files to give the analyst a terrain elevation map of the region of the scenario.

Electromagnetic Signature Reduction

Researcher: Professor John C. Turner
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Work is continuing on this classified project. Extensive sea trials were conducted in the summer of 1993. This included data from Chesapeake Light Tower, Virginia, Port Everglades, Florida and Spratt Point, St. Croix.

Proof-of-concept was demonstrated successfully. Work is continuing on post-trial data analysis and planning for future trials.

Application of Residue Number System Arithmetic to Adaptive Beamforming

Researcher: Professor Peter R. Turner
Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania and
Naval Academy Research Council (ONR)

The problem of beamforming is that of tuning an array of antennas so as to maximize the reception in the direction of a desired signal while minimizing the signal strength in the direction of a jammer signal. In the situation where the receiving antennas and/or the transmitting station is moving then the array must be continually retuned and this must be achievable in a very small time-frame. This is known as adaptive beamforming.

The combined requirements of speed and size imply that conventional computing equipment and standard solution techniques are not suitable. The problem is therefore to obtain the appropriate mix of numerical algorithm, arithmetic system and computer architecture to meet these demands.

The specific objective was to develop such a solution using Residue Number Systems and the associated RNS arithmetic for which a prototype processor has been developed for NAWC by a team from the University of Florida. Residue number systems represent an integer by its residues moduli a basis set of prime numbers. The arithmetic is then performed on these residues relative to the appropriate moduli. The representation is unique for integers within the range of the product of the basis-moduli.

There are two principal mathematical formulations of the beamforming problem. One of these results in the need to solve a (complex) linear system of equations for the weights. The coefficient matrix for this system is the covariance or correlation matrix of a collection of "snapshot" vectors of the received signal on the elements of the processor array. This formulation of the problem was the subject of the research.

Residue Number Systems and the associated RNS arithmetic offer the potential for very fast arithmetic since all internal arithmetic is performed on short-word integers. However there are difficulties; the integers are not closed under division or square-root operations, for example. This rules out the use of standard tools of numerical linear algebra unless the non-RNS operations can be eliminated or at least minimized so as to reduce the cost of conversion between the RNS and other arithmetic systems.

The proposed solution is to modify the Gauss elimination algorithm by eliminating the divisions entirely. However, the cost of this is rapid growth in the magnitude of the matrix elements as the elimination proceeds. This is in conflict with the restricted dynamic range offered by RNS arithmetic systems. The principal development this year was in the analysis of the dynamic range requirements and precision of the computational solution in order to determine the practicability of the RNS approach.

Implementation and Applications of Level-Index Arithmetic

Researcher: Professor Peter R. Turner
Sponsor: Naval Academy Research Council (ONR)

The proposal was to continue with the development of possible schemes for the eventual hardware implementation of LI arithmetic and the analysis of the algorithms used while at the same time gaining more computational experience and evidence of the potential practical value of the system via applications using software implementations of the level-index, LI and symmetric level-index, SLI arithmetic system. This was a continuation of previous work on the level-index system. This system has the virtues of eliminating overflow and underflow and using a consistent and appropriate measure of precision throughout the range of the real numbers. The advantages are offset by the fact that arithmetic will be slowed down. However, the fact that the programmer or software designer would be freed from worries about potential overflow and, therefore, from the need to scale problems will in many cases more than balance this loss.

The principal objectives were to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. Specifically, this

has led to the publication of a paper in the Proceedings of the 11th IEEE Symposium on Computer Arithmetic on the implementation and error analysis of complex SLI arithmetic. Current work is focused on software implementation of SLI arithmetic - especially on a massively parallel computer in which the processor array will be used to simulate hardware algorithms.

The methods of investigation included mathematical analysis, the development and use of algorithms for various arithmetic systems and their application to the evaluation of mathematical functions. This included a comparative study of the various schemes. The study also included research into recent hardware design developments and their possible use in eventual implementations of the level-index scheme. The other major areas of activity here have been and are concerned with the use of parallel processors and the implications of the parallelism for the arithmetic system used.

The work is still very much alive and is likely to be continuing for several more years. It is a major undertaking involving at least four principal active contributors. The new proposal is for continuation of this potentially very important line of research.

A Computational Search for Polynomial Relations Among Standing Waves

Researcher: Associate Professor William D. Withers
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project was to test computationally for the validity of certain polynomial relations relating different eigenfunctions of the Laplacian on domains of various shapes. The most fundamental example of such relations is provided by the multiple-angle identities for the cosine function (the eigenfunctions of the Laplacian on an interval being cosine waves of various frequencies.) The polynomial function appearing in the multiple-angle identities give rise to the well-known Chebyshev family of orthogonal polynomials.

In previous work with collaborators, the researcher showed that similar polynomial relations hold among the eigenfunctions of the Laplacian satisfying Neumann boundary conditions on a triangle or higher-dimensional region which is a fundamental region for a reflection group on Euclidean space. As in the case of the cosine function, these relations give rise to associated families of orthogonal polynomials (in several variables.) In the current project, other types of domains were considered: triangles which are fundamental regions for reflection groups in the hyperbolic plane and arbitrary isosceles triangles in Euclidean space.

The group-theoretic apparatus which was heavily relied on in the earlier work is unavailable or quite different for these new domains, so computational methods were used to test for polynomial relations. A heat-flow model was used to construct eigenfunctions of the Laplacian on the given domain. The question of the existence or nonexistence of the desired could be tested by the representation of particular three functions derived from the eigenfunctions as quadratic functions of two eigenfunctions. It was found that for Euclidean isosceles triangles, this representation was extremely accurate, implying the existence of the polynomial relations of interest, while the results for hyperbolic triangles were ambiguous.

Independent Research

Extensions of Aztec Diamond Tiling

Researcher: Professor Craig K. Bailey

The number of tilings of the Aztec diamond by dominoes is $2^{(1+2+...+n)}$. Several 2-dimensional and 3-dimensional extensions are considered involving different shapes used in the tiling and different shapes that are trying to be tiled. Some partial results in the 2-dimensional cases are known.

Poroelastic Models for the Seabed

Researcher: Professor James L. Buchanan

One of the pressing problems in underwater acoustics today is formulating and then solving a model for interaction of acoustic waves in a shallow ocean with the seabed. A major thrust encouraging this research is the need to investigate inhomogeneities in the seabed, which might result from manmade objects buried in the seabed, submerged wreckage, or mineral deposits.

Such investigations give rise to a class of problems known as inverse problems. Gilbert and Xu have investigated inverse problems in a finite depth ocean with a reflecting seabed and reported the results in a sequence of papers. The methodology used in these papers was first to obtain an operator which produced the far field from an incident ray scattered off the target. Then the inverse problem was formulated as an extremal problem. Such an approach could be applied to an ocean seabed model of the Biot type once a suitable fundamental singular solution is available. Moreover, the formulation of the inverse problem as an extremal problem and the

corresponding existence theory for solutions should be similar to the reflecting seabed case.

In order to test an algorithm for determining the shape of an inclusion one needs to compute the far field using a different shape of an inclusion one needs to compute the far field using a different numerical procedure than is used to invert the far field and determine the shape of the object. With this in mind a method for generating far fields is necessary. These far fields and the method of Herglotz generating functions could be used to reconstruct the object as in the case of the reflecting bottom. Currently the problem of calculating the far fields arising from a point source is being considered. Starting with Biot's model for a poroelastic sediment, a set of differential equations for the dilatations and vertical displacements in the porous skeleton and the pore fluid is derived. Then a normal modes solution is developed for the case of an ocean over a poroelastic sediment with constant Biot parameters.

The Commutative Transitive Kernel

Researcher: Professor Anthony M. Gaglione

Free groups, Λ-free groups, and word hyperbolic groups without torsion have the property that the relation "commutes with" is transitive on the non-identity elements. The class, CT, of *commutative transitive groups* is determined by the above property. Given a group G , the researcher constructs a characteristic

subgroup T(G) which has properties similar to the commutator subgroup for Abelian groups. The object of this project is to establish a theory of CT groups analogous to those for Abelian, solvable, and nilpotent groups. This project is still ongoing.

An Independence Problem in the Commutator Calculus

Researcher: Professor Anthony M. Gaglione

Let H be the free product of finitely many cyclic groups of infinite order or of order p (p is a fixed prime). The objective of this research is to determine the quotients, H_n/H_{n+1} of the lower central series of H. Presentations of these factor groups were given in previous papers of this researcher and H. V. Waldinger. The arguments, however, given in the papers alluded to are not sufficiently detailed. The objective of this project is to give the complete details of these arguments. Besides

making the researcher's papers more accessible to the general mathematical public, it is felt that this work should be of interest because it applies the collection process of P. Hall to a group which is not free, but of finite rank. The title of this project comes from the fact that a very significant part of this work is to show that a certain set of generators of lower central quotients of H is independent. These generators are, of course, certain commutators.

A Solution to the General Grand Unification Problem

Researcher: Professor Robert A. Herrmann

The three major problems on the books of Physics are: (1) give a scientific theory for how our universe may have come into being, (2) determine of what "empty" space is composed, (3) find a grand unification theory. With the publication of the final portions of this research, all three of these problems have been solved.

John Wheeler and a Princeton group attempted in 1974 to construct a pregeometry from the statistics of the propositional calculus and failed. This research has shown that a satisfactory but very subtle logical process does exist that meets theoretically all of the requirements of a Wheeler pregeometry. The method used is the reverse of the usual methods that have been employed previously. Rather than use the doubtful assumption postulated by the particle physicists that a unification of all physical theories, in this research, the entire universe is viewed externally as a collection of natural systems where the description for the time evolution of each natural system is correlated to the event sequences that occur in objective reality.

These correlated event sequences are then embedded into a nonstandard mathematical structure that is used to model various logical operators. From this the metamorphic-anamorphosis model (i.e., MA-model) is constructed. It is shown that within the MA-model there exists one entity called an ultimate ultraword w' and a force-like operator *S such that when *S is applied to w' our entire universe is formed in the correct step-by-step manner. The operator *S and the ultraword w' unify all physical theories. Further, the mathematical theory automatically yields two distinctly different objects (i.e., subparticles) from which all natural objects can be constructed, including all of the immaterial fields that might exist. This model satisfies all of the Wheeler requirements for a pregeometry including the participator concept.

A Maple Package for Decomposing Tensor Products of Representations

Researcher: Associate Professor W. David Joyner

The investigators have written a Maple package, which should be uploaded onto Maple's internet share-library site daisy.uwateloo.ca soon. The purpose is to decompose tensor products of fundamental representations of simple Lie algebras using Kashiwara's theory of crystal graphs.

A Counterexample to Igusa's Conjecture on the Functional Equations of Igusa Local Zeta Functions with Canonical Measure

Researchers: Associate Professor W. David Joyner

The researchers worked through and completed Martin's counterexample to Igusa's conjecture on Igusa local zeta functions built from canonical measures. The example was built out of the triple Cartan product of the 1st, 3rd, and 5th fundamental representations of SL(7). The results will be published by Roland Martin, a mathematician currently working at the National Security Agency.

The Langlands-Igusa Method for the Group G

Researchers: Associate Professor W. David Joyner

The investigators are working on applications of Igusa theory to problems in representation theory and orbital integrals. Their goal is to apply the Langlands-Igusa method to investigate orbital integrals on the p-adic group G_2. Considerable work has already been done by the first author, so the present objective is to complete and polish the work already done.

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MATHEMATICS

Divisibility Properties of Multiple Harmonic Sums

Researchers: Associate Professors Michael E. Hoffman and
Courtney H. Moen

Let $\zeta_n(m)$ denote the harmonic sum $\sum_{i=1}^{n} \frac{1}{i^m}$. There are some well known results about divisibility of such sums by powers of a prime p when $n = p-1$. For example, if $p > m + 1$, then p divides the numerator of $\zeta_{p-1}(m)$, and if also $p > m+2$ and m is odd, then p^2 divides this numerator. The researchers seek similar results for the multiple harmonic sums

$$A_n(i_1, i_2, \cdots, i_k) = \sum_{n \ge a_1 > a_2 > \cdots > a_k \ge 1} \frac{1}{a_1^{i_1} a_2^{i_2} \cdots a_k^{i_k}},$$

where $i_1, i_2, \ldots, i_k$ are positive integers.

If $n = p - 1$, several divisibility results can be obtained immediately from the single-sum case and earlier results of the first author. There are also some easily-proved mod p relations among the multiple sums. But there also appear to be some less obvious mod p relations, e.g., $A_p(1,2,1)$ appears to vanish mod p. Many of these identities follow a pattern of "duality" in the exponent sequences that is analogous to one observed for infinite multiple harmonic series in earlier work of the first author.

There is also a phenomenon that has no counter-part in the single-sum case: there are interesting mod p results when $n = 2p - 1$. The authors have shown that for $k \le 4$ and $p > i + 1$ prime, the sum

$$S_{k,i} = \sum_{i_1 + \cdots + i_k = i} (i_1, \cdots, i_k)$$

is divisible by p. They conjecture this is true in general.

The authors are continuing to look for and prove mod p identities as mentioned above, and hope to prove the conjecture stated above.

Automatic Pattern Recognition Devices Based on Statistical Analysis of Time Series Spectra

Researcher: Associate Professor John S. Kalme

The project is a continuation of previous years' work. The researcher has been studying statistical mechanics, quantum mechanics, and the physics of semiconductor devices, in order to gain an understanding of semiconductor devices and micro-electronics. The researcher wants to be able to put together off the shelf hardware devices, microprocessors, and micromechanisms to build various digital controllers and pattern recognition devices. The automatic pattern recognition devices, based on statistical stepwise discriminant analysis, hierarchial cluster analysis, autoregressive spectral linear prediction of time series spectra, and multiple and partial coherence spectra, computes estimated autoregression and Cepstral coefficients for the spectra. The estimated spectra at various frequencies and also the autoregression coefficients are fed into a stepwise discriminant analysis program to perform classification.

The researcher wrote the programs in 1978. Some of the procedures proved successful in ship noise origin and structure borne noise path identification and were published in the August 1984 issue of the *Journal of Sound and Vibration*. The investigator has also been studying digital signal processing. He has come to the point where he has to learn microelectronics and hardware in order to continue the implementation of the software which so far has been developed and will develop in the future.

Restricted Orbit Equivalence for Discrete Amenable Groups

Researcher: Associate Professor Janet W. Kammeyer

The central question in Ergodic Theory is to ask whether two dynamical systems are "the same". For example, suppose (X,A,μ) is a Lebesgue probability space. Let T be a measure preserving, finite entropy, ergodic Z-action on (X,A,μ). Two such systems are orbit equivalent if there exists a bimeasurable, measure preserving map Φ between them which preserves the T-orbits, as sets. In 1959, H. Dye proved that any two ergodic Z-actions are "the same", in the sense that they are orbit equivalent.

If more restrictions are placed on this orbit equivalence Φ, so that, for instance, the map Φ must also preserve the order of the orbits, then any two ergodic Z-actions which are orbit equivalent in this restricted sense are said to be isomorphic. In 1970, D. Ornstein proved that any two Bernoulli (i.e. independent) Z-actions of equal entropy are "the same", in the sense that they are isomorphic.

These two notions of "sameness" may be thought of as two ends of a spectrum of restricted orbit equivalence, with orbit equivalence putting essentially no restriction on Φ and isomorphism putting a quite rigid restriction on Φ. In 1985, D. Rudolph published a general theory of

restricted orbit equivalence for Z-actions. He defined the "size" m of an orbit equivalence, and defined what it meant for two Z-actions to be "the same", in the sense of being m-equivalent. He then proved a theorem which gave a characterization of those Z-actions which are m-equivalent.

In 1992, this researcher, working jointly with D. Rudolph (University of Maryland), developed a notion of restricted orbit equivalence for ergodic actions of the higher dimensional group Z^d. Currently, this researcher, again working jointly with D. Rudolph, is describing restricted orbit equivalence for more general discrete amenable groups.

More specifically, the researchers have defined a notion of m-equivalence for ergodic actions of discrete amenable groups. The researchers have shown that the earlier notions of m-equivalence for Z-actions and Z^d-actions are simply special cases of this more general approach.

They will define notions of m-entropy and m-finitely determined, and prove that any two m-finitely determined actions of equal m-entropy are m-equivalent.

Numerical Solution of Integro-Differential Equations

Researcher: Associate Professor Thomas J. Mahar

Certain problems describing shear band formation can be reduced to Volterra integro-differential equations in space and time. Analytic solutions to these problems are difficult to construct and numerical solutions are difficult to generate. Further, complicated singularities in the transform plane make it difficult to establish stability properties of the solutions. A simpler class of problems in finite dimensions is being used to study mid-point discretization of these integro-differential equations.

Laplace and Z transforms have been used to demonstrate that the continuous and discrete problems have the same stability properties. Numerical computation was performed using two variants of the same mid-point equations. Even for a simple, one-dimensional problem, the numerical results were strongly dependent upon which version of the mid-point equations was implemented. This subtle failure of the associative law of addition is under study.

Arithmetic Properties of Generalized Apery Sums

Researcher: Associate Professor Courtney Moen

In the course of his famous 1978 proof that the zeta function is irrational at 3, Apery introduced various combinatorial sums, now known as Apery sums. These played a crucial role in his proof. Since then, numerous researchers have studied these sums, discovering many interesting number-theoretic properties which they

satisfy. There are also important connections with modular forms and algebraic varieties.

In this project, the researcher introduces various generalizations of Apery sums and studies their properties and relationships with other objects in number theory.

Divisibility of Multiple Harmonic Sums

Researcher: Associate Professor Courtney Moen

This is a project in combinatorial number theory in which the researcher studies divisibility properties of multiple harmonic sums, generalizing the classical results for a simple harmonic sum.

The Short Monomial for the $[p^k]$-series

Researcher: Associate Professor George Nakos

This research was again conducted when the author was visiting the Johns Hopkins University while on sabbatical from the U.S. Naval Academy. This work attempts to generalize Nakos' *The Short Monomial for the $[2^k]$-and $[3^k]$-series* to any prime number p.

Currently, computer computations by Nakos have lead to a partial generalization of the last paper. There is strong indication that a general pattern will emerge. If the pattern is confirmed, all of Nakos' earlier proofs generalize. Jim Martino rewrote Nakos' Mathematica programs into Maple. The effect is that one can compute faster and go higher using the Johns Hopkins math department SPARC 10 station.

This completed project will vastly generalize earlier results by D. C. Johnson of the University of Kentucky.

Teaching the Harvard Reformed Calculus Course

Researchers: Professors Howard L. Penn, James M. D'Archangelo,
Carol G. Crawford, Charles C. Hanna, Thomas Sanders and Associate Professor Jody Lockhart
and Commander William M. Kroshl, USN

This project's purpose was to investigate the teaching of a reformed calculus course at the Naval Academy.

There are a number of objectives associated with reformed calculus. Some of the objectives are: (1) Place more emphasis on the understanding of concepts, and (2) Place more emphasis on applications. Every concept should be presented three ways: graphically, numerically, as well as analytically. Formal definitions should follow more specific examples. Students should learn to work in groups, be able to read problems, determine solutions and articulate the meaning of the solutions. Reformed calculus courses take advantage of the presence of technology and place less emphasis on the routine computations which form such a major portion of a traditional calculus course. During 1992-1993, the Mathematics Department invited several prominent mathematicians involved in reformed calculus to speak to the department. These included David Smith from Duke, Deborah Hughes Hallet from Harvard, Burt Waits from Ohio State, Tom Dick from Oregon State, and Chris Avery and Don Small from the Military Academy. A committee was formed to select a reformed calculus textbook. The book produced by the Calculus Consortium based at Harvard was selected. During the summer of 1993, Chuck Hanna and Howard Penn attended the workshop for the consortium at Harvard. Together they wrote a syllabus for Calculus I. In addition, Howard Penn took a minicourse on the materials given at the National Summer meeting in Vancouver. The seven instructors met once a week to exchange ideas. The final for Calculus I contained 10 multiple choice questions that were common for all students in regular and reformed calculus.

The results of the uniform final are found in a paper published by Howard Penn. The student evaluations for the first semester were generally favorable. The students were offered a choice to take a regular Calculus III or Reformed Calculus III. Seventy-eight out of 116 selected to take Reformed Calculus III.

The Mathematics department has decided to teach all sections of Calculus for the class of 1998 using the materials of the Consortium for Calculus based at Harvard. Howard Penn will develop a Reformed Calculus III course to be taught in fall 1994. The grades of the students who took reformed calculus n courses such as Calculus III, Differential Equations, Physics, and Electrical Engineering will be tracked for comparison. All sections of Calculus I and II will be taught out of the reformed calculus book.

Transversely Hemitropic and Transversely Isotropic Stress-Strain Relations

Researcher: Associate Professor John F. Pierce

The sets of polynomial stress-strain relations for elastic points which are transversely hemitropic and transversely isotropic are presented as algebraic projective modules having 20 and 10 generators, respectively. Complete sets of relations among the generators are presented which allow minimal representations to be deduced involving 10 and 6 generators, respectively. The results are established using the Cartan decomposition of the representation of the adjoint action of the two-dimensional rotation and orthogonal groups on the space of three-by-three symmetric matrices. The results are compared to known representations for nonlinear, transversely isotropic stress-strain relations, for linear, transversely hemitropic relations, and transversely isotropic ones.

Spontaneous and Induced Symmetry-Breaking Bifurcations of the Equilibrating Orbits for Pseudo-Rigid Bodies

Researcher: Associate Professor John F. Pierce

The work examines what changes can occur to the orbit of trivially equilibrating configurations for a pseudo-rigid body possessing a natural state when perturbing loads are applied. The question is analyzed by formulating it as a problem of bifurcation on a group orbit to which the theory of singularities applies. The analysis indicates how alterations of the orbit depend upon features of the perturbing load, and of the material composing the body.

DTED Map Program Software, Version 2.0

Researcher: Professor Thomas Sanders

This software was written in MacApp and C++ to display and manipulate Digital Terrain Elevation Data (DTED) files on a Macintosh Computer. As part of the *Strike Warfare Effectiveness and Survivability Analysis System*, this program can aid in the design and implementation of effectiveness and survivability studies for cruise missiles. The DTED map program developed allows for quick usage of computer generated color displays of the (large) DTED data files and allows the analyst to use the computer to determine radar site locations and masking. It is also capable of planning cruise missile flight paths. A significant amount of programming assistance was provided by Andy Scheck of JHU/APL in this effort.

Examples in Number Theory Generated with Mathematica

Researcher: Associate Professor JoAnn S. Turisco

This research involves the explicit computation of forms associated to smooth maps between Euclidean spaces which were defined by T. Ono. He has shown that, for the case of affine maps, these forms are the Legendre polynomials, and for certain deformations of Hopf maps, the forms turn out to be the hypergeometric polynomial.

In this project, forms associated to more general maps between higher dimensional spaces are computed. The computations involve the determination of eigenvalues of large matrices whose elements are multivariable polynomials. These computations are almost impossible by hand, and are even difficult by computer. So far the results yield generalized hypergeometric functions and their integrals over the unit sphere.

Another aspect of this project is the construction of normed bilinear mappings between spheres, using Mathematica to generate families of rectangular matrices,whose elements are 0, 1, or -1, which satisfy a kind of idempotent and anti-commutative property. This

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research continues, with the hope that new examples will yield insight into some old, well-known, and still unsolved problems in number theory.

Frequency of Overflow and Underflow Failure in Scientific Computing

Researcher: Professor Peter R. Turner

This work is the continuation of earlier work in which the author considered this question from the viewpoint of arithmetic overflow resulting from addition and subtraction on the basis of the logarithmic distribution of numbers. The assumption of the logarithmic distribution combined with a further assumption that the distribution of numbers should be smooth and independent of the arithmetic base leads to the claim that the exponents of floating-point numbers should be uniformly distributed. It was on this basis that alarming frequencies of overflow and underflow were obtained. The further observation was made there that these results were unrealistically pessimistic for scientific computing.

This departure from realism was explained by stating that the distribution of exponents is not uniform in practical scientific applications because of the choice of units and the scaling of the problem. It is the purpose of this work to examine the distribution of exponents in an attempt to obtain a more realistic model for the occurrence of overflow and underflow failure. Initially, this is applied only to a random process taking no account of the special nature of any particular process.

The basic models used to develop the results are described beginning with a discrete model which is directly comparable to the floating-point situation. This is followed by a continuous model which can be thought of as modeling the situation which would be encountered when using logarithmic arithmetic. Such arithmetic systems have been proposed as alternatives to floating-point and extensive work has been carried out in obtaining hardware designs for their implementation. The logarithmic number systems are essentially equivalent to level 1 of the level-index and symmetric level-index systems.

It is shown here that the continuous model mirrors very closely the behavior of the discrete model; a fact which makes it suitable for the analysis of the floating-point situation. This analysis shows that, as the number of multiplicative operations increases, the exponent distribution becomes a spline function of increasing degree which mimics more and more closely a normal distribution function. This remains true until exponent spill begins to take over.

This will be followed by the presentation of computational evidence on the frequency of exponent spill as a result of an extended sequence of multiplications and divisions. One striking aspect is the marked difference between balanced and unbalanced initial ranges of exponents. In the case of even very slight unbalance - which may simply be the result of good scaling applied within an unbalanced floating-point system - the frequency of exponent spill grows alarmingly. Account is taken here of whether the exponent spill is reported before or after the normalization of the result.

The computational analysis is extended to study the effects of the various "fix-ups" which are used to overcome overflow/underflow failure. These include the use of Not-A-Number, NAN, symbols and their interaction. The "zero-infinity" fix-up in which underflow is replaced by zero and overflow by the largest representable number is also included.

The work culminates in conclusions and recommendations for design of computer arithmetic systems. Principal among the recommendations are that the floating-point systems should be normalized in a balanced way and that exponent ranges should be significantly extended.

Almost Isosceles Pythagorean Triples

Researcher: Professor William P. Wardlaw

A *pythagorean triple* is an ordered triple (a,b,c) of positive integers a, b, c such that $a^2 + b^2 = c^2$; such a triple is *almost isosceles* if c - b = 1 (*hyppie*) or |a - b| = 1 (*leggie*). It is shown that (a,b,c) is a hyppie almost isosceles pythagorean triple if and only if a, b, and c are positive integers such that $a^2 = 2b + 1 = b + c$. Thus,

there is one such triple for each odd square a^2. It is also shown that (a,b,c) is a leggie almost isosceles pythagorean triple with b even if and only if $a = u_{n+1}^2 - u_n^2$, $b = 2u_n u_{n+1}$, and $c = u_{n+1}^2 + u_n^2$ for some positive integer n, where (u_n) is the sequence defined by $u_0 = 0$, $u_1 = 1$, and $u_{n+2} = 2u_{n+1} + u_n$. (The stipulation that b is even is just a convention, since a + b must be odd in any almost isosceles pythagorean triple.) A number of other relationships are developed. This work continues research conducted ten years prior. The results have been extended, polished, written up, and submitted for publication.

Good Matrices - Integer Matrices which Preserve GCD

Researchers: Professor William P. Wardlaw and R. Bruce Richter

When x is an r-tuple of integers, gcd x can be written to denote the greatest common divisor of the entries of x, and an r can be defined by n matrix A with integer entries to be good if gcd xA = gcd x for every integer r-tuple x. This study discusses a number of properties of such matrices, some of which are included in the following theorem. By letting A be an r by n matrix with integer entries. Then the following are equivalent:

(1) A is good. (2) The gcd of all of the r by r subdeterminants of A is 1. (3) A has an integral right inverse. (4) A can be enlarged to an n by n integral matrix having an integral inverse. These results are generalized to principal ideal rings.

Research Course Projects

A Look at Two Singular Functions

Researcher: Midshipman 1/C Alexander Bullock III, USN
Adviser: Professor Mark Kidwell

Midshipman Bullock looked at how singular functions (continuous, monotonic functions with derivative zero everywhere that the derivative exists) arise in branches of mathematics other than analysis. In particular, he looked at the bold play function from probability theory and a comparison of two functions that arise in the theory of dynamical systems.

Crystallographic Groups and M. C. Escher

Researcher: Midshipman 1/C Patrick M. Burger, USN
Adviser: Associate Professor Jody M. Lockhart

The proof that there are exactly seventeen isomorphism types of plane crystallographic groups is studied. First, basic facts and definitions about isometries of the Euclidean plane are reviewed. Next, the order of rotations in crystallographic groups is considered and the proof of the crystallographic restriction - that a rotation in a crystallographic group can only have order 1,2,3,4, or 6 - is indicated. Those crystallographic groups with rotations of order 2 and 3 are considered in detail. The proofs and explanations given in Roger Lyndon's book *Groups and Geometry* are rewritten and expanded; the many details and explanations that are omitted in Lyndon's book are given.

Finally, a number of the plane crystallographic groups are illustrated with works of the graphic artist M. C. Escher.

An Integer Programming Model to Aid in Project Management

Researcher: Midshipman 1/C Scott M. Wilson, USN
Adviser: Professor W. Charles Mylander

Dr. Michael Golda of the Cryogenic Engineering Laboratory requested the development of a tool to aid his laboratory in responding to changes in funding for the development of a superconducting magnet to be included in a new minesweeper. The rapid development of new minesweeping technology necessitates the simultaneous development of several alternative units for use in the minesweeper. The lab is constantly being requested to review the impact of dramatic changes in the level of funding on their project. In addition, as the development proceeds, there are changes in the perception of the value of the tasks making up the project. The researchers created a model where the decision to fund a task is a 0-1 variable. A prototype version of the model was implemented using the student version of the "General Algebraic Modeling System" (GAMS) and applied to the development of the magnet in the ALISS minesweeper.

Nullity Patterns of Bisymmetric Matrices

Researcher: Midshipman 1/C Kristen Culler, USN
Adviser: Professor Geoffrey L. Price

As a part of her honors project, Midshipman Kristen Culler succeeded in doing some original research on a combinatorial problem in matrix theory which generalized a portion of her faculty adviser's recent work in the field of operator algebras. Using a bitstream sequence consisting of elements in a finite field, one may form an n by n matrix A_n for each n which is skew-symmetric with respect to the main diagonal, symmetric with respect to the main diagonal, symmetric with respect to the secondary diagonal, and which depends upon the first n elements of the bitstream. Culler discovered some patterns related to computing the nullity of these matrices, which were subsequently applied to count the number of n by n matrices of this type which are invertible. Over the past year, her work was revised and extended by her adviser and has been submitted as a co-authored paper for publication in a research journal.

A Comparison of Classical Regression Techniques and Artificial Neural Networks in Predicting the Performance of Second Lieutenants at the Basic School

Researcher: Midshipman 1/C Thomas H. Hayghe, USN
Advisers: Professor Thomas J. Sanders and
Major Pete F. Long, USMC

The principal objective of this honors project was to determine if artificial neural networks (ANNs) could be used to build a mathematical model that would be useful in predicting the performance of Marine Corps' Second Lieutenants at The Basic School (TBS). The primary tool for constructing such models has been statistical regression, but with the recent claims of some researchers concerning the predicting power of ANNS, interest was expressed by Headquarters, Marine Corps in a comparison of the two tools' abilities to predict TBS performance. Secondary objectives of the project were to determine any background factors that significantly affect performance at TBS, and to compare the mathematical models developed from the two approaches.

The data used in the study was provided by Headquarters, Marine Corps. Background data and performance scores were provided on year groups 1985-1991. The study only used the data from year group 1991. Also provided was a software package named Statistical Neural Network Analysis Package (SNNAP) which was produced by RRC, Incorporated and Metrica, Incorporated in conjunction with the Human Resources Directorate, Manpower and Personnel Research Division at Brooks Air Force Base. SNNAP has routines to build both ANN models and simple linear regression models.

It was used in this project to construct and test an ANN model for the year group 1991. The regression model was constructed using QuattroPro for Windows, version 5.0.

The background data provided included the following parameters that were considered for inputs to the models: gender, race, ethnic group, General Competence (GCT) score, source of commission, college degree major, marital status, and physical fitness test (PFT) score. Several binary variables were constructed for some of the parameters. For example, gender was input as a binary variable that had the value 0 if the officer was female, and 1 if the officer was male. The test scores were tried both as a continuous variable (the value of the score) and as a binary variable (e.g., 1 if the officer had a GCT score above 125, 0 otherwise). For the ANN model, there was no need to determine either if a particular variable was significant or if there was a strong correlation between variables. The regression model, however, required that there be no strong correlation among the input variables, and that all the input variables be significant.

The database also provided the following performance measures: academic score, leadership score, military skills score, composite score (weighted average of the other three scores), academic rank, leadership rank, military skills rank, composite rank, academic third, leadership third, military skills third and composite third. The output variable (measure of performance to be predicted) chosen was composite score. This was primarily due to the requirement for a continuous variable for the regression model.

The ANN model constructed turned out to be a poor model, and could not be validated using data from year group 1991 that was not used in the training of the model. In the construction of the regression model, the most significant input variables were GCT score and PFT score (in order of significance). Together these two contributed about 19% of the observed variation in the composite scores. The other parameters combined predicting a composite score with the linear regression model had an estimated standard deviation of 2.82. The standard deviation from the mean was 3.23. Thus using the regression model would give a 95% confidence that the prediction was 5.6 from the actual composite score, as compared to approximately 6.4 from the composite score using the mean as the predictor. Because the difference is so small (given that the composite scores are generally between 75 and 95), and the 95% confidence interval is so large, the regression model, although valid, does not appear to be very useful as a predictor of composite scores at TBS.

Publications

ANDRE, Pierre P., Professor, "Submarine Tactics in a Sporadic Active Sonobuoy Field", Applied Physics Laboratory, Johns Hopkins University Report.

This report studies tactics which might be employed by a submarine if it finds itself prosecuted by an active sonobuoy field. The report gives a possible tactic which would allow the submarine to exit the field while keeping the risk of detection low.

CRAWFORD, Carol G., Professor, "Critical Features for Aircraft Classification", Technical Report for Naval Air Warfare Center, (August 1993).

This paper presents findings of an independent investigation into Critical Features for Target Classification for the Naval Air Warfare Center at Warminster, Pennsylvania. The critical features are utilized within an aircraft classification system where information is provided from various separate sensors. The ultimate goal is to derive "optimal" set fractures that will be successful in terms of correctness and will be robust against error and noise present in the data supplied. Specific algorithms as well as graph representations are presented.

FOWLER, Gary O., Associate Professor, "Closed-loop Degaussing Using Moment Correlation with a Physical Model," Naval Surface Warfare Center Report CARDIVNSWC-C-TR-85-93/42, (June 1994).

Degaussing a ship means to reduce (to zero) the magnetic signature of the ship. This makes it less vulnerable to detection. Degaussing is accomplished by running the correct electrical current through coils onboard the ship. Closed-loop refers to the technique of using onboard sensors to determine the correct coil currents. A closed-loop degaussing algorithm using moment correlation has been developed by researchers at the Academy and NSWC-Annapolis. This classified research and report evaluates the effectiveness of this algorithm on a scale model of a ship.

HERRMANN, Robert A., Professor, "Ultrauniform," *RS Quarterly*, 30, 3 (Dec. 1993), 127.

In this brief note, the MA model concept of ultrauniform behavior is discussed relative the uniformity of nature. It is shown that, from the viewpoint of the MA-model, natural system behavior which is classified as chaotic or random is actually ultrauniform. Ultrauniformity is then related to theological concepts.

HERRMANN, Robert A., Professor, "The Scientific Existence of a Higher Intelligence," CRS Quarterly, 30, 4 (March 1994), 218-222.

It is shown that within the D-world model there exists a logical operator that satisfies the information theory requirement of a higher intelligence for the generation of the informational content carried by the DNA-molecule. The theoretical existence of such a higher intelligence is then applied to various philosophic areas such as Ratio-nalism, Realism, and Scientism. It is shown that the logical basis for these philosophies is inconsistent and, hence, most of the philosophical conclusions associated with these philosophies are logically invalid. Further, the descriptive content for the behavior of such a higher intelligence is then compared with such concepts as they are described within theological literature.

HERRMANN, Robert A., Professor, "A Special Isomor-phism Between Superstructures," *Kobe Journal of Mathematics*, 10 ,(1993), 125-129.

The final question relative to the basic embedding of intuitive logical operators into a nonstandard structure is solved, in complete generality, in this article. Suppose that the two nonempty sets X, Z are given and $X \cap A = Z \cap A$, where A is a set of atoms within ZFA set-theory. The concept called n-atomic is defined and it is shown that if there exists a bijection from $X_o = X \cup A$ onto $Zo = Z \cup A$, then for two superstructures, with ground sets Xo and Zo, each nth superstructure level is set-theoretically isomorphic. Further, the isomorphism constructed preserves all kth superstructure levels where $0 \le k \le n$. Using the concept of the transitive closure, a criterion is given that implies when a set is n-atomic for all n. It is then shown that for the set of equivalence classes E used to construct the superstructure that formally investigates the consequence operators and the coded set of intuitive words i [W] needed to create the intuitive superstructure for the informal investigation of consequence operators, the sets $E \cup A$, i [W] $\cup$ A are n-atomic for all n. It follows that these two superstructures are level for level isomorphic since the embedding i followed by the

equivalence class quotient map, coupled by the identity map on atoms is a bijection from i [W] $\cup$ A onto $E \cup A$.

LOCKHART, Robert, Associate Professor, "Conformal, parabolic and spectral properties of complete Riemannian metrics on non-compact manifolds," *Global Analysis in Modern Mathematics*, Publish or Perish Press, Houston Texas, (1993), 15-31.

A sufficient condition for the essential spectrum of a Laplacian on a non-compact manifold to contain 0 is derived. Corollaries include necessary conditions for the Laplacian to be Fredholm and for the Fredholm inverse to be a compact operator. It is also shown that the set of parabolic Riemannian metrics that have 0 in the essential spectrum is dense in the set of Riemennian metrics.

MALEK-MADANI, Reza, Professor, "A Limiting Stability Criterion for Steady-State-Bands in Thermo-Plasticity", Proceeding of the 4th international conference on Plasticity and its Applications, (1993), 1-4.

This paper contains an analysis of a system of partial differential equations that model simple shearing of a slab of thermo-plastic material. In previous work a class of constitutive relations was identified that leads to a variational characterization of steady-state solutions. When the stress-strain law has the property that the stress is zero if the strain-rate vanishes, the stability properties of the steady-state solutions is identified purely in terms of the shape of a solution branch in a certain distin-guished bifurcation diagram. When, on the other hand, the stress has a nonvanishing yield-stress, the steady-state solutions that are constructed via a phase-plane analysis do not have enough smoothness property. The author will present a limiting argument that establishes the stability of the appropriate branch of the bifurcation diagram for the latter class of constitutive laws. A numerical experiment that points to the parameters that change the behavior of solutions is presented.

MCCOY, Peter A., Professor, "Near-circuitry of the Error Curve in Chebyshev Approximation of Solutions to a Class of Elliptic Partial Differential Equations in the Complex Plane," *Journal of Computational and Applied Mathematics, Special Issue on Computational Complex Analysis*, 46, 1-2 (1993) 315-326.

Let Φ be a solution to the Helmholtz equation on an open disk. Let Φ_n^* be an approximation of Φ relative to a certain subspace of solution whose restriction to the boundary of the disk are polynomials of degree at most n. The error curve arises as the image of the boundary of the

the disk under $\Phi - \Phi_n^*$. Geometric properties of the curve relating the modulus and winding number characterize the best and near-best approximate solutions and their relation to Chebyshev approximation.

MCCOY, Peter A., Professor, "Special Functions, Boundary Value Problems and Linear Elliptic Partial Differential Equations," *SIAM Activity Group on Orthogonal Polynomials and Special Functions*, extended abstract in 4, 1, (Fall 1993), 4.

In signal processing, Shannon's theorem allows the recovery of a bandlimited signal from values sampled at a discrete set of frequencies. This concept is viewed in the context of elliptic boundary value problems of order ≥ 2 on a bounded domain Ω with the $\partial \Omega \in C^\infty$. The idea is to find a sampling theorem for the solution of the BVP.

A procedure is set up for constructing a complete set of orthogonal sampling functions with properties similar to the "sinc" function in Shannon's theorem. The solution of the BVP is expanded as a series in terms of these sampling solutions and the boundary data sampled at a discrete set of spatial frequencies.

MCCOY, Peter A., Professor, "Sampling Theorems Associated with Boundary Value Problems for Elliptic Partial Differential Equations in R^N, *Complex Variables: Theory & Application*, 23 (1993) 269-281.

Signal processing methods are placed in a function-theoretic setting. The Dirichlet problem associated with the canonical second order elliptic pde is considered on a bounded star shaped domain $\Omega \subset R^N$. Solutions are constructed by sampling boundary data that is "bandlimited" and "finite energy" in the spacial frequency regime. Lagrange type interpolation formulae follow.

MICHAEL, T.S., Assistant Professor, (with Stucker, Aaron), "Mathematical pitfalls with equivalence classes," *PRIMUS*, 3 (1993), 331-335.

In this pedagogical article the authors discuss the need for students to understand equivalence classes at least at an intuitive level in order to avoid natural errors in undergraduate mathematics courses.

PENN, Howard L., Professor, "Comparison of Test Scores in Calculus I at the Naval Academy," *Focus on Calculus*, a Newsletter for the Calculus Consortium Bases at Harvard University, 6 (1994), 6-7.

In the Fall of 1993, the Mathematics Department taught seven sections of Reformed Calculus. These sections were converted from a traditional course using the Calculus book by Swokowski. Students were not given an option as to which course they took. At the end of the semester, all of the students in both sections took final exams that included 10 multiple choice questions that were the same for both courses. The students taking Reformed Calculus had a higher average on nine of the ten questions including several that were computational in nature.

PRICE, Geoffrey L., Professor, co-author, "Cocycle Conjugacy Classes of Shifts on the Hyperfinite II_1 Factor," *Journal of Functional Analysis*, 121 (1994), 275-295.

In this paper, the authors use bitstream sequences of 0's and 1's to construct shifts n the hyperfinite von Neumann algebra factor of type II_1. The image of the algebra under a shift is a subfactor of the same type. In this paper, the authors consider those shifts whose subfactor index is 2. Such shifts are in some ways related to the classical Bernoulli shifts on product spaces, and knowledge about their structure helps to cast light on the study of how factors may be embedded in one another. The authors study an equivalence relation on these shifts which is called strong cocycle conjugacy. They show that a necessary condition for a pair of shifts of index 2 to be strongly cocycle conjugate is that their corresponding bitstreams agree after some point. Some of their techniques have led to some results in the study of the combinatorics of Toeplitz matrices over finite fields.

THURMAN, Katie P., Lieutenant Commander, USN, "Optimizing Ship Berthing," *Naval Research Logistics Journal*, 41, 1, (February 1994), 1-15.

Ship berthing plans reserve a location for inbound U.S. Navy surface vessels prior to their port entrance, or reassign ships once in port to allow them to complete, in a timely manner, reprovisioning, repair, maintenance, training, and certification tests prior to redeploying for future operational commitments. Each ship requires different services when in port, such as shore power, crane, ordnance, and fuel. Unfortunately, not all services are offered at all piers and berth shifting is disruptive and expensive: A port operations scheduler strives to reduce unnecessary berth shifts. This article presents an optimization model for berth planning and demonstrates it for Norfolk Naval Station, which exhibits all the richness of berthing problems the Navy faces.

TURNER, Peter R., Professor, co-author, *Numerical Methods and Analysis, Instructor Manual,* McGraw Hill: New York, (1993).

This is the Instructor's Solution manual to accompany the authors' textbook *Numerical Methods and Analysis* which is a senior level undergraduate or first graduate text in Numerical Analysis with its emphasis clearly rooted in practical applications. The desire to develop good numerical routines for solving problems drives the mathematical development rather than the other way round but the methods presented are analyzed fully. Coverage includes computer arithmetic and errors, iterative solution of nonlinear equations, evaluation of elementary functions, interpolation, approximation and curve-fitting (including splines, Bezier curves and Fast Fourier Transform), linear systems of equations, optimization, numerical integration, numerical solution of differential equations, boundary value problems, eigenvalues and an introduction to the ideas of parallel processing. The instructor manual is accompanied by a software diskette containing Turbo Pascal units implementing the algorithms discussed in the text.

TURNER, Peter R., Professor, "Complex SLI Arithmetic: Representation, Algorithms and Analysis" 11th IEEE Symposium on Computer Arithmetic, IEEE Computer Society, Washington DC, (July 1993), 18-25.

In this paper the extension of the SLI system to complex arithmetic is discussed. The natural form for representation of complex SLI quantities is in modulus-argument form and this can be sensibly packed into a single 64-bit word for the equivalent of the 32-bit real SLI representation. The arithmetic algorithms prove to be only slightly more complicated than for real SLI arithmetic. The paper describes the representation, arithmetic algorithms and the control of error within these algorithms.

TURNER, Peter R., Professor, co-author, "Adaptive Beamforming Using RNS Arithmetic," 11th IEEE Symposium on Computer Arithmetic, IEEE Computer Society, Washington DC, (July 1993), 36-43.

This paper is concerned with the solution of the adaptive beamforming problem using an algorithm-architecture-arithmetic combination which has the potential for use on a small platform such as aircraft or sonobuoys. The arithmetic used is the RNS system implemented on an array of processors which can be reassigned as the algorithm proceeds. The underlying algorithm is a

modified Gauss elimination. The (non-RNS) division operations are eliminated in favor of some scaling and the adaptive use of the processor array to accommodate the growth in the dynamic range.

TURNER, Peter R., Professor, co-author, "Modified Gaussian Elimination for Adaptive Beamforming Using Complex RNS Arithmetic," NAWC-AD Technical Report No. 94112-50, (1994).

This technical report is concerned with the solution of the adaptive beamforming problem using an algorithm-architecture-arithmetic combination which has the potential for use on a small platform such as aircraft or sonobuoys. The arithmetic used is the RNS system implemented on an array of processors which can be reassigned as the algorithm proceeds. The underlying algorithm is a modified Gauss elimination. The (non-RNS) division operations are eliminated in favor of some scaling and the adaptive use of the processor array to accommodate the growth in the dynamic range. The underlying algorithm, arithmetic and processor architecture are all discussed in detail.

WARDLAW, William P., Professor, "Problem 1425," *Mathematics Magazine,* 66 (June 1993), 192.

Let p be a prime number and let A be a $(p - 1) \times (p - 1)$ matrix over the field of rational numbers such that $A^p = I \neq A$. Show that if f(x) is any nonzero polynomial with rational coefficients and degree less than $p - 1$, then f(A) is nonsingular.

WARDLAW, William P., Professor, "Problem 10318," *The American Mathematical Monthly,* 100, 6 (June-July 1993), 590.

Suppose that A is an n by n matrix with rational entries whose multiplicative order is 15; i.e., $A^{15} = 1$, an identity matrix, but $A^k \neq 1$ for $0 < k < 15$. For which n can one conclude from this that

$$I + A + A^2 + \cdots + A^{14} = 0 \ ?$$

WARDLAW, William P., Professor, "Problem 10324," *The American Mathematical Monthly,* 100, 7 (July-August 1993), 688.

Let a and m be positive integers and define the sequence (x_n) by $x_0 = 1$ and $x_{n+1} = a^{x_n}$. Show that there is a positive integer N such that $x_h \equiv x_k \pmod{m}$ whenever $N \leq h \leq k$.

Presentations

BAKER, B. Mitchell, Associate Professor, USNA, "Chaotic Dynamical Systems and Cardiac Arrhythmias", invited colloquium, Virginia Polytechnic Institute and State University, 25 February 1994.

BAKER, B. Mitchell, Associate Professor, USNA, "A Dynamical Systems Approach to Cardiac Excitation", invited joint Dynamical Systems Seminar/Colloquium, Boston University, 30 March 1994.

BUCHANAN, James L., Professor, "Advances in Function Theoretic Methods", Hypermembrane Shell Theory, special session at the AMS annual meeting, Cincinnati, Ohio, 11 January 1994..

CHAMBERLAIN, Michael, W., Professor, "Rank Determination for a Noisy Matrix," given at the Technical Seminar presented by the Faculty Members of USNA at Naval Air Warfare Center, 4 November 1993.

CRAWFORD, Carol G., Professor, Chair of Session on "Total Colorings of Graphs", 25th Southeastern International Conference on Combinatorics, Graph Theory and Computing, Boca Raton, Florida, 8 March 1994.

CRAWFORD, Carol G., Professor, "Graph-Matching Neural Networks for Automated Fingerprint Identification", 25th Southeastern International Conference on Combinatorics, Graph Theory and Computing, Boca Raton, Florida, 11 March 1994.

CRAWFORD, Carol G., Professor, (Panelist), "Calculus Reform", Regional Conference at Montgomery College, 16 April 1994.

GAGLIONE, Anthony M., Professor, "Generalization of Free Groups and Universally Free Groups", Groups 1993, Galway/St. Andrews, Galway, Ireland, 12 August 1993.

GAGLIONE, Anthony M., Professor, "Baumslag Groups and Lyndm Groups", SUNX-Albany, New York, 30 October 1993.

GAGLIONE, Anthony M., Professor, "An Indepen-dence Problem for Commutators," Brooklyn, New York, April 10 1994.

GAGLIONE, Anthony M., Professor, "Free Groups and Universally Groups", New York Group Theory Seminar, New York, 4 February 1994.

GRANT, Caroline G., Associate Professor, "Kahler Metrics for Singular Algebriac Varieties", Weizmann Institute, Rehovot, Israel, 7 March 1994 and 12 March 1994.

GRANT, Caroline G., Associate Professor, "Kahler Metrics for Singular Algebriac Varieties", Var Ilan University, Tel Aviv, Israel, 10 March 1994.

GRANT, Caroline G., Associate Professor, "Generating Functions for Kahler Metrics on Singular Algebraic Spaces", U.S. Naval Academy, Annapolis, Maryland, 31 March 1994.

HERRMANN, Robert A., Professor, "Partial Differential Equations, Separation of Variables, and Relativistic Alterations," Maryland, District of Columbia, Virginia Section of the Mathematical Association of American Fall Meeting, Montgomery College, Takoma Park, Maryland, November 13 1993.

HOFFMAN, Michael, Associate Professor, "Divisibility Properties of Harmonic Sums", U.S. Naval Academy Mathematics Colloquium, Annapolis, Maryland, 16 March 1994.

KAMMEYER, Janet W., Associate Professor, "What Your Advisor Can't Tell You: How to Prepare for a Career Teaching College Mathematics", University of Maryland Student-Faculty Colloquium, College Park, Maryland, 13 December 1993.

KAPLAN, Harold M., Professor, "Late-Starting Martingales in the Intersection of Bayesianism and Frequentism, Mid-Atlantic Regional Probability and Statistics Day, US Food and Drug Administration, Rockville, Maryland, 6 November 1993.

KONKOWSKI, Deborah A., Associate Professor, "Black Holes, Big Bangs and Cosmic Strings", Physics Colloquium, Bryn Mauer College, Bryn Mauer, Pennsylvania., October, 1993.

KONKOWSKI, Deborah A., Associate Professor, "A Stability Test of the Reissner-Nordstrom Cauchy Horizon Lanczos Centenary Conference, Raleigh, North Carolina, 12-17 December, 1993.

KONKOWSKI, Deborah A., Associate Professor, "A Stability Test of the Kerr Cauchy Horizon", Lanczos Centenary Conference, Raleigh, North Carolina, 12-17 December, 1993.

KONKOWSKI, Deborah A., Associate Professor, "A Stability Test of the Kerr Cauchy Horizon", Aspen Center for Physics, Aspen Colorado, June 1994.

MALEK-MADANI, Reza, Professor, "An Energy Estimate in Thermo-Visco-Elasticity", Colloquium, University of Pisa, Italy, June 1993.

MALEK-MADANI, Reza, Professor, "Steady-State Shear Bands", Colloquium, University of Rome, Italy, June 1993.

MARUSZEWSKI, Richard F., Associate Professor, "Introduction to UNIX", U.S. Naval Academy Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 1993.

MARUSZEWSKI, Richard F., Associate Professor, "Introduction to the Mathematics Department Computer Systems", U.S. Naval Academy Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 1993.

MARUSZEWSKI, Richard F., Associate Professor, "SUN Windowing Systems", U.S. Naval Academy, Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 93.

MARUSZEWSKI, Richard F., Associate Professor, "A Technical Word Processor:Publisher", U.S. Naval Academy Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 1993.

MCCOY, Peter A., Professor, "Special Functions, Boundary value Problems and Linear Elliptic Partial Differential Equations," Minisymposium on "Applications of Special Functions," SIAM 41, annual meeting, Philadelphia, Pennsylvania, 14 July, 1993.

MCCOY, Peter A., Professor, "Symmetry and Simple Boundary Value Problems," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 10 November, 1993.

MCCOY, Peter A., Professor, "The Use of Symmetry in Solving Simple Boundary Value Problems on the Line" Math Association of American, MD-DC-VA Section Fall Mtg., Montgomery Community College, Takoma Park, Maryland, 13 November 1993.

MCCOY, Peter A., Professor, "Interpolating Scattering Solutions", Special Session on Advances in Function Theoretic Methods, 100th annual meeting ,The American Mathematical Society, Cincinnati, Ohio, January 1993.

MCCOY, Peter A., Professor, "The How To" of How to Characterize Far-Field Patterns," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 13 April 1994.

MICHAEL, T.S., Assistant Professor, "Sphere of Influence Graphs," presented at a Colloquium at U.S. Naval Academy, Annapolis, Maryland, October 1993.

MICHAEL, T.S., Assistant Professor, "Sphere of Influence Graphs,: invited Colloquium at the University of Louisville, October 1993.

MICHAEL, T.S., Assistant Professor, "Sphere of Influence Graphs:A Survey," presented at the 25th International Conference on Combinatorics, Graph Theory and Computing, Boca Raton, Florida, March 1994.

MICHAEL, T.S., Assistant Professor, "Degree Sequences of Graphs," presented at the Combinatorics Seminar at George Washington University, Washington D.C., April 1994.

PENN, Howard L., Professor, "Fun with Parametric Equations," Mathematical Association of America Sectional Meeting, Tacoma Park, Maryland, November 1993.

PENN, Howard L., Professor, co-presenters, "Teaching Reformed Calculus at the Naval Academy," Mathematics Department Seminar, Annapolis, Maryland, March 1994,

PENN, Howard L., Professor, "A Comparison of Test Scores for Students Taking Reformed and Regular Calculus,: Mathematical Association of America Sectional Meeting, St. Mary's, Maryland., April 1994.

PENN, Howard L., Professor, "Teaching Calculus with The Harvard Consortium Materials," Day long workshops, Blacksburg, Virginia, April, 1994.

MATHEMATICS

PIERCE, John F., Associate Professor, "Spontaneous Symmetry-Breaking Bifurcations for Pseudo-Rigid Bodies. Address to the Faculty, Department of Mathematics, University of Pisa, Pisa, Italy, June 1993.

PIERCE, John F., Associate Professor, "Representing Transversely Isotropic Stress-Strain Relations for Liquid Crystals." Applied Mathematics Seminar, Department of Mechanics, College of Engineering, University of Pisa, Pisa, Italy, June 1993.

PIERCE, John F., Associate Professor, "Stoppelli's Problem for Pseudo Rigid Bodies". Faculty Seminar, Department of Mathematics Politecnico, Milano, Italy, July 1993.

PIERCE, John F., Associate Professor, "Spontaneous Symmetry-Breaking Bifurcations for Pseudo-Rigid Bodies. Invited Address, Special Section on Bifurcation and Symmetry-Breaking, Annual Meeting of the American Society of Mechanical Engineers, New Orleans, Louisiana, November 1993.

PIERCE, John F., Associate Professor, "Spontaneous Symmetry-Breaking Bifurcations for Pseudo-Rigid Bodies. Invited Address, Theoretical and Applied Mechanics, Department, Cornell University, Ithaca, New York, February 1993.

PRICE, Geoffrey L., Professor, "Matrix Rank and Eigenvalue Problems", NAWC Science and Technology Seminar, 4 November 1993.

PRICE, Geoffrey L., Professor, "Shifts on the Hyperfinite II_1 factor", American Mathematical Society Annual Meeting, Cincinnati, Ohio, 15 January 1994.

TURNER, Peter R., Professor, "Complex SLI Arithmetic: Representation, Algorithms and Analysis", ARITH 11, Windsor, Ontario, June 1993.

TURNER, Peter R., Professor, and Barry J. KIRSCH (NAWC) "Adaptive beamforming using RNS arithmetic", ARITH 11, Windsor, Ontario, June 1993.

TURNER, Peter R., Professor, "Complex SLI arithmetic", SIAM National Meeting, Philadelphia, Pennsylvania, July 1993.

TURNER, Peter R., Professor, and Barry J. KIRSCH (NAWC) "Adaptive beamforming using RNS arithmetic", SIAM National Meeting, Philadelphia, Pennsylvania, July, 1993.

TURNER, Peter R., Professor, Adaptive beamforming using RNS arithmetic, NAWC-AD, November, 1993.

TURNER, Peter R., Professor, Modified Gauss elimination for adaptive beamforming using RNS arithmetic, Arizona State University, Comp Math Pro-Seminar, March 1994.

TURNER, Peter R., Professor, Dynamic range and precision analysis for adaptive beamforming, SIAM National Meeting, San Diego, California, July 1993.

WARDLAW, William P., Professor, "Good Matrices-Integer Matrices which Preserve GCD", USNA Mathematics Department Colloquium, 23 March 1994.

WARDLAW, William P., Professor, "Good Matrices-Integer Matrices which Preserve GCD", MD-DC-VA Section of the Mathematical Association of America spring meeting, St. Mary's College, St. Mary's City, Maryland, 16 April 1994.

Oceanography

Captain C. A. Martinek, USN
Chair

Academic year 1993-1994 was particularly productive in terms of U.S. Naval Academy oceanographic and meteorological research. The Oceanography Department research philosophy is guided by two baseline themes: (1) maximize midshipmen involvement, while (2) employing "total quality" techniques. The faculty accomplished some very significant successes with respect to these principles.

Twenty three students participated in the fifth summer research cruise aboard the Naval Academy's oceanographic platform, YP686. More than one-hundred oceanographic stations were completed in this four week endeavor; physical, biological, chemical, meteorological, and geologic data were collected and processed; state-of-the-art equipment and techniques were employed, as were classical but effective methods and tools. Midshipmen including two Trident Scholars and ten Honor Students, were involved in direct, "hands-on" research through enrollment in the Department's Independent Research courses. These research projects, directed by both civilian and military faculty, introduced the students to the excitement and responsibility of data collection and analysis. The midshipmen invariably commented on

the invaluable learning experience that this exposure to the scientific method represents for them. During formal presentations of their research, at the end of each semester, these young investigators come together and share the results of their efforts and experiences with the faculty and senior administrators. As a result of the Department's Independent Research program, five midshipmen went on to deliver oral and poster presentations at professional conferences of the American Geophysical Union and The Oceanography Society.

One highlight for this academic year was an award by the National Science Foundation to Associate Professor David R. Smith (in conjunction with the American Meteorological Society). The total grant of $866,520 will fund the Maury Project - a K-12 teacher enhancement program on the physical foundations of oceanography. Approximately 75 teachers from across the country will attend one (or more) summer workshops at U.S. Naval Academy between 1994 and 1996.

The faculty continue to be actively involved in scientific and scholarly endeavors, without losing sight of the need to have at their disposal the latest technologically advanced instrumentation and methodology.

Sponsored Research

Special Sensor Microwave/Imager (SSMI) Applications

Researchers: Commander Christopher R. Gunderson, USN
and Midshipman 1/C Cynthia Viernes, USN
Sponsor: Naval Research Laboratory, Monterey, California

The Special Sensor Microwave/Imager (SSMI) will soon be commonly available to Fleet Oceanographers. It has a unique ability to remotely sense wind speed and precipitation through cloud cover. Naval Research Laboratory processing equipment allowing special sensor

imagery as well as, gridded meteorological fields. This work will explore potential special sensor microwave/image tactical applications through use of the Naval Research Laboratory equipment.

The Natural Rainbow & Passive Remote Sensing

Researcher: Visiting Professor Raymond L. Lee, Jr.
Sponsor: National Science Foundation

This proposal continues research support for optical remote sensing of the natural rainbow. Researchers define natural rainbows as those seen in rain showers, or in water droplet sprays which have drop size spectra similar to rain showers. In an earlier National Science Foundation Grant, it was demonstrated that remote sensing of such geographysical phenomena can clearly show whether existing theories are adequate, unnecessarily detailed, or inadequate to explain naked-eye observations.

Ultimately, the goal is to develop a consistent theory of the natural rainbow, meaning with a nearly uniform level of complexity from the light source to the observer. Each portion of such a theory is necessary, and the whole theory is sufficient, to account for the appearance of all natural rainbows. Earlier research suggests that, in order to develop such a theory, the sophistication of the observations must increase by examining detailed spectroradiometric data from natural rainbows, a task not possible with available equipment.

The project includes both theoretical and experimental aspects with the theoretical part divided into the forward problem and the inverse problem. In the forward problem, a consistent theory of the natural rainbow is developed and used both to circumscribe the range of possible images, and to calculate the appearance of specific bows. In the inverse problem, the information content in the variability of natural bows and the meteorological circumstances that give rise to a particular bow is determined. In the experimental studies comparisons are made between the chromaticity curves of natural and theoretical rainbows to assess whether the theory adequately circumscribes the variations of nature. In addition, selected natural bows are used to perform inversions.

Independent Research

Acquisition and Manipulation of Side-Scan SONAR Data in the Chesapeake Bay and Vicinity

Researcher: Associate Professor Peter L. Guth

The department's side scan sonar and YP686, is being used to look at bedforms and bottom features in the Chesapeake Bay near Annapolis. During the summer cruise the area of operations was extended to the Delaware Bay and the continental shelf. Bottom Sample grabs, and the remotely operated vehicle with video camera, will provide validation of the side scan data. Manipulations, enhancement, and display of the results on personal computers has led to their incorporation into our academic program. One midshipman worked on this project as his Trident Scholar study.

Analysis of Digital Topography and Bathymetry

Researcher: Associate Professor Peter L. Guth

A toolbox for the analysis of digital topography and bathymetry is under development. This toolbox, a collection of programs running on MS-DOS microcomputers, allows the manipulation and display of gridded data sets, and the calculation of various parameters like FFT, semi-variograms, and fractal dimensions. This analysis will help to better characterize landforms and their development.

Oceanographic Investigation of the Chesapeake Bay

Researchers: Associate Professor Peter L. Guth, Assistant Professor Mario Vieira, Liuetenant Commander David W. Jones, USN, Liuetenant Commander Douglas S. Dillner, USN and Midshipmen 1/c Christy Goode, USN, 1/c Murzban Morris, USN, 1/c Norman Presecan, USN, 3/c David A. Beebe, USN, 3/c John P. Bruzza, USN, 3/c Kerry L. Cummings, USN, 3/c Abigail D. Goss, USN, 3/c Lagena K. Gray, USN, 3/c Matthew O. Heisel, USN, 3/c Andrea K. Johnson, USN, 3/c Kelly E. Kast, USN, 3/c Lori Krsulich, USN, 3/c Sarah C. McGann, USN, 3/c Jason J. Mitchell, USN, 3/c Erica A. Museler, USN, 3/c Kyle A. Nurminen, USN, 3/c Keith M. Powell, USN, 3/c William J. Ryan, USN, 3/c Sam P. Trongkamsataya, USN, 3/c Angela M. Tuttle, USN, 3/c Brian C. Wiechowksi, USN, 3/c Miles A. Woodard, USN and 3/c Rebecca A. Zuwallack, USN

During the summer of 1994, the Oceanography Department conducted a military summer elective research cruise in conjunction with the Division of Professional Development. More than one hundred oceanographic stations were occupied throughout the Chesapeake Bay. Data obtained related to physical, biological, geological, and chemical parameters. Technologically advanced instrumentation and modern techniques of data reduction were used by the midshipmen. Results of this cruise were presented to the Academic Dean and Provost and the Oceanography Department Faculty.

Research Course Projects

An Examination of the Synoptic-scale Processes Responsible for Rapid Intensification of an Extratropical Cyclone: Case Study of the "Blizzard of 1993" (12 - 15 March 1993)

Researcher:: Midshipman 1/C Michael K. Jones, USN
Adviser: Associate Professor David R. Smith

Explosive cyclogenesis is the rapid development of an extratropical cyclone. The cyclone must have a central pressure drop of at least 24 millibars in 24 hours. Explosive cyclones are relatively rare compared to their more normally developing counterparts. However, they are much stronger, produce more precipitation, and are much more destructive than normal extratropical cyclones.

Atmospheric conditions that enhance such rapid intensification are a strong baroclinic environment, strong low level convergence and upper level divergence, deep convection, strong upper level vorticity, and positive heat and moisture fluxes. All these factors need to combine concurrently for effective rapid deepening to classify a storm as an explosive cyclone. This happened in the "Storm of the Century", the blizzard that occurred between the 12th and 15th of March, 1993. An atmospheric wave moved into a baroclinic environment with both low level convergence and upper level divergence resulting in rapid pressure falls. The low pressure center then traveled across the Gulf of Mexico, proceeded up the coast drawing in moisture from the Atlantic, and creating a strong line of convection. Strong cyclonic vorticity and positive vorticity advection combined with other features to creating an explosive storm. After a period of explosive deepening, these conditions either weakened or dispersed so the storm eventually began to dissipate.

This project was performed in collaboration with operational meteorologists at the National Weather Service Forecast Office in Sterling, Virginia.

The Role of Tropopause Undulation in the "Blizzard of 93" (12-15 March 1993)

Researcher: Midshipman 1/C Curtis E. Holliday USN
Adviser: Associate Professor David R. Smith

Tropopause undulations are large scale waves in the upper atmosphere at the boundary between the troposphere and the stratosphere. These waves with a wave length of approximately 4000 kilometers can have a significant effect on surface cyclones. With stratospheric air lowering and warming adiabatically in the trough of the wave, there is less overall pressure in an air column above a surface low pressure area. This, combined with an increase in the vertically-averaged temperature of the air column, decreases the hydrostatic pressure at the surface and allows an existing low pressure system to intensify to possibly explosive levels.

This phenomenon is reviewed in the case study of the storm of 12-15 March 1993, which grew to blizzard proportions as it moved up the East Coast of the United States. Via the use of the program PC-GRIDDS, a large-scale wave observed at the 300 and 200 millibar levels, with warmer air located in the trough, moved from the central United States and contributed to the development of a surface cyclone in the Gulf of Mexico. This wave followed the track of the storm up the East Coast and helped contribute to the intensification of this cyclone. Following the example of Hirschberg and Fritsch (1991), this study examines tropopause undulations and determines its impact on the development of the 12-15 March 1993 storm. This project was performed in collaboration with operational meteorologists at the National Weather Service Forecast Office in Sterling, Virginia.

A Comparison of Two Cases of Explosive Cyclone Development over the East Coast of the United States

Researcher: Midshipman 2/C Brad L. Artery, USN
Adviser: Associate Professor David R. Smith

Major winter storms, characterized by heavy snow or rain, strong winds, and large tidal surges often strike the East Coast of the United States. Resulting problems such as power outages, damaged property, and clean-up efforts cost millions of dollars yearly. In addition, vehicle accidents due to icy roads and poor visibility as well as shipping casualties in high seas cost many lives. The large number of factors which can either help or hinder cyclone development and the lack of sufficient ocean-based observations make these storms extremely difficult to predict.

The primary objective of this research is to determine what factors lead to the explosive development of these winter storms. This will be accomplished by comparing two recent East Coast winter storms. The first storm to be investigated is the "Storm of the Century" which devastated the East Coast from 12-15 March, 1993. Record amounts of snowfall and low pressure readings were set all along the coast. This extremely powerful cyclone will be compared with a less severe storm during the winter of 1993-94. (The actual case will be determined later.)

A number of meteorological variables are examined in order to determine which play a primary role in explosive cyclone development. This data is obtained through conventional observations as well as numerical model output from the National Meteorological Center. By comparing the data, a better understanding of the conditions most favorable to major winter storm development will be reached. This in turn can aid meteorologists in predicting the occurrence of this violent phenomenon.

Correlation of Coral Bleaching Events and Remotely-Sensed Sea Surface Temperatures

Researcher: Midshipman 1/C Michael W. Gleeson, USN
Adviser: Adjunct Assistant Professor Alan E. Strong

The frequency of coral reef bleaching events has increased dramatically over the past decade, and is suspected by some to be an ecological alarm of global temperature change. Corals bleach in response to environmental stress as implicated by recent high temperature events. In order to investigate the relationship between coral reef bleaching and sea surface temperature trends, National Oceanagraphic and Atmospheric Administration's Nighttime Multichannel Sea Surface Temperatures (MCSST) records from 1981-1992 were analyzed [daytime MCSST have been shown to be positively biased]. These satellite-derived Advanced Very High Resolution Radiometer temperatures were verified regionally with in-situ temperature records from buoys or high-quality research data. After establishing the regional and time-dependent accuracy of the satellite data, the MCSSTs were correlated with reported episodes of coral reef bleaching.

Results from key reef sites in the Caribbean [including Bermuda], and equatorial Pacific and Indian oceans are presented. Each MCSST time-series was then compared with records from biologists at the sites, when available, in an effort to develop an MCSST index of coral reef bleaching. Several sites have been included where no bleaching has been observed. Using these indices, it will be possible, not only to provide early warnings of potential bleaching events, but also to revisit coral reefs that may have been bleached during the past decade and not have been reported.

Changes in the Southwest Monsoon and Ocean Productivity in the Arabian Sea as a Result of the El Chichon Eruption

Researcher: Midshipman 1/C Julie A. Preyer, USN
Adviser: Adjunct Assistant Professor Alan E. Strong

Examination of the weekly Coastal Zone Color System-derived ocean pigment time-series from 1979 to 1985 reveals interesting seasonal, monsoonal, and El Nino Southern Oscillation variability. These measurements are providing biological information at time and space scales that have never been available from conventional means. A major volcanic eruption [El Chichon] in 1982 has also been examined for an overall effect on oceanic productivity that has been hypothesized, due to an extended period of diminished insolation in the tropics. Relatively minor changes are noted, but evidence is seen for a more significant monsoonal response that resulted in changes in regional productivity. Computations are presented that represent sum aggregates of annual production in all of the areas examined, such as: both Northern and Southern Hemisphere Tropics, Caribbean Sea, and Arabian Sea. The results show a reasonable year-to-year stability in ocean productivity and provide good benchmark values to continue these assessments with the SeaWiFS color data slated to be available later this year. This data will be a valuable contribution to global climate monitoring as researchers examine oceanic responses for signals of both long and short-term changes in current systems and basin productivity.

Interpreting Current Data from an Advanced Doppler Current Profile Anchor Station in the Delaware Estuary

Researcher: Midn 1/C Philip Dwyer, USN
Adviser: Assistant Professor Mário E. C. Vieira

An anchor station was occupied in the Upper Delaware Estuary, off Reedy Island, for the duration of one tidal cycle on 29 June 1992. The vessel mounted 1200 Hz Acoustic Doppler Current Profiler was utilized to gather current data in one meter bins. Current direction, speed and orthogonal current components at different depths

were analyzed. An interpretation of vertical shifts in direction, magnitude and phase of the current is offered.

A perturbation in the ebb flow is related to the proximity of a tributary creek.

A Comparison Study Between Current Meter and ADCP data

Researcher: Midn 1/C Brent Kinman, USN
Adviser: Assistant Professor Mário E. C. Vieira

A comparison study was performed between current data retrieved from InterOcean S-4 electromagnetic current meters and a R&D Instruments Acoustic Doppler Current Profiler (1200 Hz vessel mounted version). The data was taken during one tidal cycle at an anchor station in the Chesapeake Bay (mouth of the Patuxent River) during a research cruise with midshipmen from the U.S. Naval Academy in June 1993. Two S-4 current meters were hung over the side of the ship at depths of 2 and 4 meters below the surface. Identical 1 meter depth bins were selected from the ADCP record. The two pairs of current time series were compared and correlated. The results are presented and discussed.

Publications

FOERSTER, John W. Professor, "Sentinel Species: Some Biologically Active Trace Metals in the Livers of the Oyster Toadfish *(Opsanus tau)*. (with Smart, Correll and Edsall) Proceedings of the Coastal Oceans Conference (1994), 1994-2008.

Oyster toadfish *(Opsanus tau)* are a resident part of the estuarine benthic food web from the New England States to Florida in the U.S.A. They are a sentinel species with the potential to extract toxic environmental trace metals.

To test this hypothesis, the author studied toadfish resident in the Chesapeake Bay near Annapolis, Maryland, U.S.A. This area is away from any direct industrial or commercial effluents carrying trace metals but has concentrations of trace metals in the benthic sediments. Since the toadfish is a resident, non-migratory benthic predator, the department feels it is useful in studying trace metal contamination and eventually modeling metal movements in a biological system. This study concentrates on trace metals found in the physiologically important organ, the liver. Our study uses a proton induced x-ray emissions (PIXE) system to analyze for the trace metals. The PIXE system is a rapid method of determining trace metal types, concentrations and an archiving method for samples. Present analyses of various size toadfish show that the livers contained concentrations of chromium (5.9-51.7 mg/L), copper (3.3-26.0 mg/L), and zinc (8.6-29.9 mg/L). The trace metal amounts vary as a function of the size, age, and sex of the fish. Copper and chromium concentrations deplete with age after the reproductive phase, while zinc concentrations increase.

Generally, the trace metals have an accumulation pattern of chromium>zinc>copper that is different from the zinc>copper>chromium in the sediments of the Atlantic and Gulf Coasts of the United States. Thus, the life history of the animal appears as an important factor in trace metal accumulation. This leads to postulating a conceptual model for trace metal flow through this biological system. Although establishing that trace metal concentrations appear linked to the life history stage of the toadfish, the department plans further work on the impact as well as protective mechanisms.

SMITH, D. R., Associate Professor, Co-author: "Meeting Report on the Third International Conference on School and Popular Meteorlogical and Oceanographic Education", *Bulletin of the American Meteorological Society*, 75, 3, (1994), 435-444.

The Third International Conference on School and Popular Meteorological and Oceanographic Education was held 14-18 July 1993 in Toronto, Canada. This conference was attended by approximately 150 educators, meteorologists, oceanographers, and government officials representing 12 countries. The themes of this conference were the role of meteorology and oceanography in the formal science education of students in grades K-12 and the enhancement of scientific literacy of the public in order to permit individuals to make better use of products and services provided by the national environmental services and the media. 60 formal presentations plus 2 poster sessions and 6 workshops provided information on

educational programs as well as a variety of classroom activities on meteorological and oceanographic topics.

SMITH, D. R., Associate Professor, Co-Author: "AMS Project ATMOSPHERE - University of Oklahoma 1993 Workshop for Atmospheric Education Resource Agents", *Bulletin of the American Meteorological Society*, 75, 1, (1994), 95-100.

During the summer of 1993, Project ATMOSPHERE in cooperation with the University of Oklahoma School of Meteorology conducted a workshop to enhance both meteorological background and leadership skills of AMS Atmospheric Education Resource Agents (AERAs).

Fifty-eight teachers representing 39 states and the District of Columbia attended this workshop, which focused on atmospheric water processes and severe local storms. In addition to lectures and laboratory activities, AERAs also visited a variety of research and operational support facilities in the Norman area. This workshop was the third phase of training for AERAs, who represent the AMS in their local areas, providing instructional guidance for teachers and curricular input on the atmospheric sciences to their respective local and state educational agencies.

SMITH, D. R., Associate Professor, Co-author: "Meeting report on the Second AMS Symposium on Education", *Bulletin of the American Meteorological Society*, 74, 9, (1993), 1714-1719.

Precollege science education has attracted much attention in recent years. Government agencies, professional societies, universities, private corporations, and concerned individuals have all examined ways in which they might develop partnerships with teachers, schools, and school districts to enhance science education. For, example, the American Meteorological Society (AMS), through Project ATMOSPHERE, has undertaken an initiative to improve K-12 science education through a partnership with science teachers from across the country. In addition, there are several other educational outreach efforts throughout the atmospheric science community to enhance the study of weather and climate at the precollege level. In recognition of these educational outreach programs, AMS convened the 2nd Symposium on Education. This two-day event focused on partnerships to improve science education in the K-12 classrooms. Presentations included an update on AMS Project ATMOSPHERE activities, precollege outreach programs by universities, and precollege outreach programs by other agencies.

SMITH, D. R., Associate Professor and GUNDERSON, C. R., CDR, USN : "Physical Oceanography and Meteorology Curriculum at the United States Naval Academy: Preparing Future Naval Officers for the Operational Environment in the 21st Century", *Preprints of the Third AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, (1994), 49-52.

Naval officers conduct military operations from a variety of platforms: ships, aircraft, and submarines. An important consideration for any naval officer, regardless of the warfare specialty, is the impact of the environment on the weapon system. Clearly, knowledge of the environment and an understanding of how it affects one's weapon system is of vital importance to the naval warrior.

The mission of the United States Naval Academy (USNA) is to prepare midshipmen for their future careers as naval officers. The Oceanography program at USNA is a unique program, designed to provide future naval officers with a thorough understanding of the ocean and atmospheric environment in which they will be operating in their professional military careers. This undergraduate program focuses on the scientific disciplines of physical oceanography and meteorology with practical application toward naval operations.

This presentation will describe the Oceanography program at the U.S. Naval Academy. The Oceanography program builds upon a core of mathematics, science, engineering, and professional military courses taken by all midshipmen with a curriculum of physical oceanography and meteorology courses. There are a wide variety of upper division elective offerings which include biological, chemical, geological and physical oceanography, meteorology, hydrography, remote sensing as well as independent research opportunities. The presentation will focus on how the most recent curriculum revisions are designed to prepare the midshipmen as they prepare for their future naval careers in the 21st century.

SMITH, D.R., "Project ATMOSPHERE Summer Workshops for the Atmospheric Education Resource Agents (AERA) Program: An Update, *Preprints of the Third AMS Symposium on Eduacation*, Amer. Meteor. Soc., Boston, Massachusetts, (1994), 3-6.

Project ATMOSPHERE is the K-12 educational program of the American Meteorological Society. A major component of Project ATMOSPHERE is the Atmospheric Education Resource Agent (AERA) program, a network of pre-college teachers to assist with the implementation of the AMS K-12 educational initiatives. This paper will describe the summer training workshops for

K-12 teachers in the AERA program conducted by Project ATMOSPHERE.

The training program for AERAs consists of three summer workshops. The initial two-week workshop, co-sponsored by AMS and NOAA, is conducted at the National Weather Service Training Center in Kansas City, MO. Each summer, approximately 24 K-12 teachers participate in this workshop, which provides an orientation to the operational aspects of the National Weather Service and an introduction to basic meteorological concepts.

Graduates of this summer program who are selected as AERAs then attend workshops during two additional summers. The first such workshop, held at Boulder, CO in 1992, consisted of an examination of the physical aspects of meteorology with an introduction to global climate change. The most recent workshop, held in Norman, OK focused on winds and atmospheric moisture, with particular emphasis on severe local storms. Both workshops, attended by approximately 50 AERAs, provided ample opportunity for participating teachers to become exposed to a variety of government and university atmospheric research and operational meteorological facilities. In addition, a significant portion of the workshops was devoted to development of leadership skills for the AERAs as they prepare for their roles as resource personnel and agents of change for Project ATMOSPHERE.

This paper will describe the training program for AERAs provided by AMS through Project ATMOSPHERE. In particular, it will focus on aspects of the summer workshops at Boulder and Norman and how it contributes to improving K-12 meteorological education.

SMITH, D.R.: "The Atmospheric Education Resource Agent (AERA) Program: Development and Implementation of a Nationwide Network of Teachers to Promote K-12 Science Education", *Preprints of the 3rd International Conference on School and Popular Meteorological and Oceanographic Education*, Amer. Meteor. Soc., Boston, Massachusetts, (1993), 31-35.

Project ATMOSPHERE is the K-12 educational program of the American Meteorological Society. A major component of Project ATMOSPHERE is the Atmospheric Education Resource Agent (AERA) program, a network of pre-college teachers to assist with the implementation of the AMS K-12 educational initiatives. This paper will describe the AERA program and its role in Project ATMOSPHERE.

AERAs are K-12 teachers from across the nation who have participated in one or more AMS workshops for teachers. These teachers comprise a national network

linked through the AMS Education Office to enhance the background of K-12 science teachers on topics in meteorology and physical oceanography. Many of these teachers first became involved with AMS K-12 educational activities through the 2nd International Conference on School and Popular Meteorological and Oceanographic Education. Today, these AERAs are conducting in-service training for their colleagues in their local or neighboring school districts as well as at state, regional, or national science education conferences. Many are also assuming leadership roles in science education organizations, providing valuable input and innovative ways to implement weather and ocean topics into science curriculum.

This paper describes the AERA program, focusing on the training provided by AMS through Project ATMOSPHERE. In addition, it also examines some of the contributions of AERAs to implement the goals of Project ATMOSPHERE and their impact on improving K-12 meteorological and oceanographic education.

SMITH, P.L.K. and SMITH, D.R.: "Developing the Five Themes of Geography through Topics in Meteorology and Oceanography", *Preprints of the 3rd International Conference on School and Popular Meteorological and Oceanographic Education*, Amer. Meteor. Soc., Boston, Massachusetts, (1993), 184-185.

The study of the atmosphere and ocean provides an opportunity for integrating material across traditional educational disciplines. From the science perspective, both meteorology and oceanography draw upon material from physics, chemistry, biology, mathematics, and computing science, providing a vast amount of interesting and stimulating examples relevant to students' experiences. Further, weather, climate, and ocean topics also can be utilized in the social studies classroom to integrate science into a broader educational experience.

Through the efforts of the National Geographic Society, a nationwide program of state geography alliances have been established to promote geography education. The intent is to utilize the cross-disciplinary nature of geography to enhance the educational experience in a more integrated fashion. Clearly, there are strong connections between weather and ocean topics and geography which can enrich the learning of both science and social studies. For example, the theme for National Geography Awareness Week this past year was water resources, which has obvious implications for the science curriculum as well as for geography and other social studies.

This paper explores the connection between the science and social studies classrooms utilizing weather,

climate, and ocean topics. In particular, this paper demonstrates how such topics can be implemented to promote the five fundamental themes of geography: location, place, relationship within places, movement, and regions. Water resources, integrating meteorology, oceanography, and geography, will be presented to demonstrate how to teach the five themes of geography across the curriculum. Such an approach is consistent with the goals of Project 2061 of the American Association for the Advancement of Science, which recommends interweaving both science and social studies as a mechanism to promote science literacy and to enhance the study of science-technology-society issues.

STRONG, A. E., Adjunct Assistant Professor, Co-author: Comparing stratospheric aerosols from El Chichón and Mount Pinatubo using AVHRR data, *Geophysical. Res. Lett, 20* 12, (1993), 1183-1186.

One of the key factors in assessing the climatic impact of the Mount Pinatubo eruption of June 15, 1991, is the relative size of this eruption as it compares with other eruptions. As a first approximation, the climatic changes observed after those earlier eruptions can be used to predict the changes to be expected from the more recent eruption. Ideally this intercomparison should be done with a common measurement system. Data from the advanced very high resolution radiometer (AVHRR) onboard the NOAA polar orbiting environmental satellite can be used to compare the optical properties of the aerosol layer produced by the two most recent major volcanic eruptions, El Chichón, early-April 1982, and Mount Pinatubo, mid-June 1991. In this paper, the error introduced into the multi-channel sea surface temperature (MCSST) fields by the volcanically-produced stratospheric aerosol layer are used to make a relative comparison of the size of the two eruptions. Also used were optical thickness (AOT) estimates from the visible reflectance channel of the AVHRR to verify that the MCSST errors are indeed related to aerosol particle concentration in the stratosphere. During the first three months following both eruptions, these comparisons reveal that Mount Pinatubo introduced slightly less than twice (1.6 to 1.9) the amount of aerosol into the stratosphere as El Chichón.

STRONG, A.E., Adjunct Assistant Professor, "Marine environmental analysis in the East Coast of the United States",*EOS, 74,* (1993), 347.

A decade of multidisciplinary analysis of the marine environment of the Chesapeake Bay, surrounding coastal areas and the adjacent shelf region has shown satellite data in combination with in situ observations and dynamical models to be useful for identifying and studying several areas of interest. These include icing conditions, effects of river runoff following heavy precipitation events, oyster harvests and diseases, blue crabs and menhaden recruitment, isotherm progression during spring and fall, and trajectories related to pollutants and oil spills. In the assessments, researchers combined meteorological observations, hydrological measurements, shipboard measurements, satellite data and dynamical modeling.

Imagery from the five channels of the Advanced Very High Resolution Radiometer (AVHRR) instrument aboard the last several NOAA Tiros-N polar-orbiting satellites has been collected and analyzed daily during the past five years for the East Coast of the U.S. and Atlantic region between 25N and 44N and 50W to 85W.

Special cruises have been conducted both spring and fall in upper Chesapeake Bay to validate satellite temperature, chlorophyll, and turbidity readings with in situ measurements. Environmental Protection Agency also conducts seasonal cruises in the Bay, collecting several standard estuarine water quality measurements. NOAA collects temperature and density data routinely at selected stations along the shore and standard meteorological data at about 20 stations in the Chesapeake region.

Evaluation of the entire decadal record of meteorological and oceanographic events in light of generally available in situ data and satellite imagery reveals the relative effectiveness of observational platforms and data type and density for monitoring and managing a valuable coastal marine resource such as the Chesapeake Bay.

GLEESON, Michael W., 1/C Midshipman, USN and STRONG, A. E., Adjunct Assistant Professor, "Applying MCSST to coral reef bleaching", *EOS, 75,* (1994), 156.

The frequency of coral reef bleaching events has increased dramatically over the past decade, and is suspected by some to be an ecological alarm of global temperature change. Corals bleach in response to environmental stress that in previous studies have been found to be associated with localized phenomena such as storm run-off, pollution, or hypersaline water outflow from a lagoon. The global increase of bleaching events over the past decade cannot always be explained by such localized phenomena. In order to investigate the relationship between coral reef bleaching and sea surface temperature trends, nighttime MCSST records from 1981-1992 were analyzed. Satellite AVHRR temperatures were verified regionally with in-situ temperature records from NOAA buoys. Once the accuracy of the satellite data was established, as a function of time, with

in-situ measurements, temperature records were correlated with known occurrences of coral reef bleaching. MCSST time series were analyzed at several key reef sites in the Caribbean, and equatorial Pacific and Indian oceans [Bermuda was also included]. Each time series was then compared with records from biologists at the sites in an effort to develop an MCSST index of coral reef bleaching. Preliminary results show a positive correlation exists between bleaching events and elevated sea surface temperatures in a majority of the sites studied.

MONTGOMERY, Richard S., 1/C Midshipman, USN and STRONG, A. E., Adjunct Assistant Professor "Coral bleaching threatens oceans, life," EOS, 75, (1994),145-147.

Coral reefs comprise a large and integral part of the coastal ocean environment. The reefs support a variety of sea life, and people around the world depend upon these resources. Damage of a global scale to the coral reefs is a frightening scenario and one that may be unfolding in the coming years. Recently, a phenomenon called coral bleaching has raised concerns about the deteriorating conditions in the world's oceans and the implications for life on the planet.

The first coral bleaching event at Bermuda in the modern record was recorded during the summer of 1988. This event was coincident with the highest recorded water temperatures in the 38 years that records have been kept at the Bermuda Biological Station for Research (BBS). During a six-week period from August 6, 1988 through September 17, 1988, the average MCSST temperature was 28.1°C. After this first bleaching event, two more events occurred, both of lesser magnitude than the first. In 1990, during a two-week period from August 26 through September 10, the average temperature again reached 28.1°C, coinciding with a "moderate" bleaching

event off Bermuda. Again in 1991, bleaching was noted during a five-week period from August 3 through September 14 when the average temperature climbed to 28.3°C. During the weeks of August 3 and August 17, MCSST reached 28.5°C. This "higher-than-normal" temperature was accompanied by a "strong" bleaching event.

Based on the three periods of recorded bleaching and their associated temperatures, 28°C has been found to be a good index by which coral bleaching events in the Bermuda region can be gauged. Each time the temperature crosses the 28°C threshold, a bleaching event occurred. Note that this index is unique to the Bermuda area and based on SST at BBS's Station-S. Tropical corals have adapted to warmer waters and their thresholds are being sought.

VIEIRA, Mário E. C., Assistant Professor, co-author, "A Comparison Study Between Current Meter and ADCP Data", *Transactions of the American Geophysical Union*, 75, 16/supp (1994), 199.

A comparison study was performed between current data retrieved from InterOcean S-4 electromagnetic current meters and a R&D Instruments Acoustic Doppler Current Profiler (1200 Hz vessel mounted version). The data was taken during one tidal cycle at an anchor station in the Chesapeake Bay (mouth of the Patuxent River) during a research cruise with midshipmen from the U.S. Naval Academy in June 1993. Two S-4 current meters were hung over the side of the ship at depths of 2 and 4 meters below the surface. Identical 1 meter depth bins were selected from the ADCP record. The two pairs of current time series were compared and correlated. The results are presented and discussed.

Presentations

FOERSTER, John W. Professor. "Critical Thinking Exercise in Biological Oceanography." Critical Thinking Workshop, Cancun, Mexico, January 1994.

FOERSTER, John W. Professor. "Biological Oceanography." Baltimore County Middle Schools, April 1994.

FOERSTER, John W. Professor. "A Total Quality Approach to Sea Grant Management." Mississippi/Alabama Sea Grant Consortium, Mississippi, June 1994.

SMITH, David R., Associate Professor, "A Case Study of the Development and Intensification of an Explosive Cyclone: The Blizzard of 12-15 March 1993)", (with Midshipman 1/C Michael K. Jones) presented at the 1994 Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 26 May 1994.

SMITH, David R., Associate Professor, "Tropopause Undulations and Their Effects on Extratropical Cyclones: A Case Study of the Blizzard of 12-15 March 1993", (with Midshipman 1/c Curtis E. Holiway) presented at the 1994 Spring Meeting of the American Geophysical Union, Baltimore, Maryland 26 May 1994.

SMITH, David R., Associate Professor, "Meteorology and Oceanography Educational Activities at the United States Naval Academy", presented at the 23rd meeting of the International Coordination Group for Meteorological Satellites, Annapolis, Maryland, April 1994.

SMITH, David R., Associate Professor, "Physical Oceanography and Meteorology Curriculum at the United States Naval Academy: Preparing Future Naval Officers for the Operational Environment in the 21st Century", (with CDR Christopher R. Gunderson, USN)", presented at the 3rd American Meteorological Society Symposium on Education, Nashville, Tennessee, January 1994.

SMITH, David R., Associate Professor, "Summer Workshop for AERAs at Norman, Oklahoma", presented at the 3rd American Meteorological Society Symposium on Education, Nashville, Tennessee, January 1994.

SMITH, David R., Associate Professor, "The Atmo spheric Education Resource Agent (AERA) Program: Development and Implementation of a Nationwide Network of Teachers to Promote K-12 Science Education", presented at the 3rd International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada, July 1993.

SMITH, David R., Associate Professor, "Developing the Five Themes of Geography through Topics in Meteorology and Oceanography", (with P.L.K. Smith), presented at the 3rd International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada, July 1993.

SMITH, David R., Associate Professor, "American Meteorological Society's Board on School and Popular Meteorological and Oceanographic Education: Past, Present, and Future", presented at the 3rd International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada, July 1993.

GLEESON, Michael W, Midshipman 1/C and STRONG, A. E. Adjunct Assistant Professor, "Applying MCSST to coral reef bleaching," Ocean Sciences Meeting of the American Geophysical Union, San Diego, California, 24 February, 1993.

VIEIRA, Mário E. C., Assistant Professor and KINMAN, N.B. Midshipmen 1/C, USN, "A Comparison Study Between Current Meter and ADCP Data", American Geophysical Union Spring Meeting, Baltimore, Maryland, 23-27 May 1994.

VIEIRA, Mário E. C., Assistant Professor, "On the Impact of Subtidal Flushing in the Ecology of Shallow estuaries", Joint Conference Marine and Estuarine Shallow Water Science and Management in the Mid-Atlantic Region, Atlantic City, New Jersey, 8-12 March 1994.

VIEIRA, Mário E. C., Assistant Professor and DWYER, P. Midshipmen 1/C, USN, "Interpreting Current Data from an ADCP Anchor Station in the Delaware Estuary", 12th Estuarine Research Federation Conference, Hilton Head Island, South Carolina, 14-18 November 1993.

Physics

Professor Robert N. Shelby
Chair

The 1993-1994 academic year was a year of active and productive involvement of the Physics Department faculty and students in a broad range of research efforts that reflected the range of applicability of physics principles and techniques. While interesting and esoteric topics such a properties of the magnetosphere of Jupiter and the neutral gas in the galactic halo were studied, much of this research emphasized the importance of understanding and using the principles and techniques of physics in addressing very practical problems. The practical problems addressed ranged from the clever use of lasers to obtain clear images in highly scattering media to the use of a tandem accelerator for pollutant identification in environmental pollution studies. The richness of these efforts is detailed in the abstracts that follow. The specific topies studied included research in physical acoustics, atomic physics, nuclear physics, non-linear optics, a broad spectrum of condensed matter physics topics, magnetic signatures, non-linear acoustics, ultrafast laser systems, the use of proton induced x-ray emissions (PIXE) in environmental and archaeological studies, planetary magnetic fields, and galactic astronomy. These projects made use of the several excellent facilities available at the Naval Academy as well as facilities at the Naval Research Laboratory and the Naval Warfare Centers.

There continues to be a strong component of the Physics Department research effort dedicated to student involvement in the research and an understanding of the importance of the faculty being involved with and sharing with their students current techniques and ideas. In addition to the required laboratory courses, there were ten significant student research projects, detailed in the following abstracts, done this year. Midshipman Todd Bode's Trident Scholar Prize winning project, sponsored by Associate Professor Engle, dealt with calculations on Jupiter's magnetosphere and was an excellent example of the quality of the work done by students.

Funding support for research done by Physics Department faculty and students this year came from the National Science Foundation, the Office of Naval Research, the Naval Research Laboratory, the David Taylor Research Center, the Naval Academy Research Council, and DuPont de Nemours, Company.

Sponsored Research

Acoustics Research

Researcher: Professor Donald W. Brill
Sponsor: Naval Surface Warfare Center, White Oak, Maryland

This study analyzed the Singular Value Decomposition (SVD) theory used to analyze the acoustic radiation from irregular structures as it is currently used by Douglas Photiadis at NRL.

Numerical analyses were made of the far field backscattering of acoustic plane waves from a diffraction grating type set of ribs.

Development Of A Coincident RBS-PIGE System With High Depth Resolution

Researcher: Professor Francis D. Correll
Sponsor: Naval Research Laboratory

Several ion-beam-analysis (IBA) techniques are commonly used to assist in the development of new or improved materials. Rutherford Backscattering Spectrometry (RBS) gives high-resolution depth profiles of sample constituents, but often cannot distinguish between constituents of similar mass. Particle-Induced Gamma-ray Emission (PIGE) easily identifies individual elements and even isotopes, but does not produce depth profiles. Unfortunately, no single technique with both capabilities appears to have been developed.

The general objective of this work was to study the feasibility of combining RBS and PIGE to obtain the desired capabilities. The key idea was to detect an ion scattered from a sample atom in time-coincidence with a gamma-ray produced in the same event. Depth profiles could be obtained from the ion-energy spectra with individual gamma-ray energies, producing separate, high-resolution depth profiles of the different sample constituents even if their masses are very similar.

The specific objectives of this project were to develop detection and signal processing methods and measure singles- and coincidence- rates for various beam and target combinations. Further goals were to choose the optimum experimental conditions and demonstrate the technique by measuring depth profiles of several similar mass elements in the same sample.

An experimental apparatus for studying ion-gamma coincidences has been assembled and tested. Energy spectra of ions and gamma rays have been measured, and apparently coincident events have been detected, but no clear signature of true (vice accidental) coincidences has been observed so far. Possibly this technique is not practical for use with the low-energy, light-ion beams available from a small accelerator or, alternatively, further refinement may be needed. Improvements are possible in the detection geometry, signal-processing electronics, and data-acquisition system, and several other beam types and energies can be tried.

Modeling The Duirnally Precessing Jovian Magnetospheric Field

Researcher: Midshipman 1/C Todd D. Bode, USN
Adviser: Associate Professor Irene M. Engle
Sponsor: Trident Scholar Program

A functional representation of the magnetic field contribution of the solar-wind-driven electric currents on the magnetopause of Jupiter is presented. The representation accounts for the precession of the magnetic axis and the consequential diurnal variation of the shape of the magnetopause. Existing models of the two interior field sources (planetary dipole and currents of trapped plasma) were incorporated into a set of 8 three-dimensional static models. Each model assumed a $10°$ tilt of the magnetic axis with respect to Jupiter's orbital plane. This set includes representations published [Engle, 1992] for a tilt toward ($\alpha = 0°$) and away from ($\alpha = 180°$) the sun in the noon-midnight meridian plane, as well as six complementary analogous models for azimuthal angles of $45°$, $90°$, $135°$, $225°$, $270°$, and 315. The representations were connected by replacing expansion coefficients with discrete continuous functions which replicated each of the 8 original static models and interpolated between them. The result is a time-dependent functional representation of the magnetic potential of the magnetopause surface currents in terms of an expansion in associated Legendre functions. This model yields predicted magnetic field components for any location within the magnetosphere as Jupiter's magnetic axis precesses during the course of a Jovian day ($9^h 55^m 41^s$).

Propagator Study Of Some Simple Resonance Phenomena

Researcher: Associate Professor John P. Ertel
Sponsor: Naval Surface Warfare Center (Code 804.1)
Annapolis, Maryland

This study involves the 1st and 2nd level development of the Propagator Solution to several standard idealized acoustics problems in physics in collaboration with Joseph W. Dickey of NSWC. In the 1st level, some simple physics problems normally solved via eigenvalue methods were completed to validate the technique unambiguously. These problems have very well known and accepted solutions which the Propagator method will reaffirm. Actually, this 1st level should be completed during the summer intersessional period under Code 804.1 funding. At the 2nd level of this project, several very idealized eigenvalue resonance problems (i.e. a perfectly uniform one dimensional string; a uniform one dimensional string with periodic bead masses; multiple simply connected two dimensional quadrilateral structures...) will be solved using the Propagator method which may then easily be extended to include deviations in symmetry. The well known perturbation methods of extending the standard eigenvalue solutions are, in contrast, long, difficult, and in many cases, fail to reliably converge.

A Propagator Study Of Resonance Phenomena

Researchers: Associate Professor John P. Ertel
Sponsor: Naval Surface Warfare Center (Code 804.1)
Annapolis, Maryland

This study, conducted in collaboration with John W. Dickey and Gideon Maidanik, involves the development of the Propagator Solution to several acoustics problems of interest to the Navy and the numerical evaluation of certain significant measurable parameters. Of the parameters evaluated, the "partial radiation efficiency" has proved most interesting in that it predicts that damping does not always reduce radiated power. In fact, it has been shown that the radiated power may well be significantly enhanced at certain frequencies when damping is arbitrarily applied.

Electrical Properties Of Polymers

Researchers: Professor John J. Fontanella and
Professor Mary C. Wintersgill
Sponsor: DuPont de Nemours, Co.

The audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for various types of polymers. Several new relaxations were observed and the activation parameters for each were determined.

Electrical Properties Of Ion Exchange Membranes

Researcher: Professor John J. Fontanella
Sponsor: Office of Naval Research

The primary objective of this work is to gain insight into ion motion in ion exchange membranes via complex impedance measurements. Work has begun on NAFION and will continue. Using state of the art devices, audio frequency impedance and admittance measurements are being carried out in a vacuum, from 10 Hz to 10^{5}Hz, 0.008K to 400K and at pressures up to several kilobars over the temperature range 100-400K. In the vicinity of room temperature, both higher (to 1 GHz) and lower (to 1 mHz) frequency measurements will be carried out.

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Thus, electrical transport and relaxation will be studied over a wide range of temperatures and pressures. Auxiliary measurements such as thermally stimulated depolarization current and thermal analysis measurements including differential scanning calorimetry, thermomechanical, thermogravimetric, and dynamic mechanical relaxation studies will also be carried out where appropriate. Optical and infrared absorption and x-ray diffraction measurements will also be performed.

Reactor Noise Analysis

Researcher: Midshipman 1/C John Ventura, USN
Adviser: Captain Matthew Forsbacka, USAF
Sponsor: Trident Scholar Program

Midshipmen Ventura's Trident project will involve measuring the Armed Forces Radiobiology Research Institute (AFRRI) TRIGA reactor dynamic parameters by means of pseudorandom noise techniques. Pseudorandom noise techniques involve operating a nuclear reactor at a low power level (cold critical) and monitoring the signals from the in-core neutron detectors while a small reactivity perturbation is inserted into the core. By randomly varying the reactivity perturbation, various harmonics in the reactor transfer function are excited. Using correlation techniques and transforming data from the detectors and reactivity input function from the time domain to the frequency domain will allow for the direct measurement of the reactor transfer function. Knowledge of the reactor transfer function will allow for the calculation of the mean-neutron-lifetime and the effective delayed neutron fraction. This project will provide an independent means of verifying the AFRRI TRIGA reactor's Inhour curve as well as the parameters used in predicting reactor transient behavior using the point reactor kinetics model.

Nuclear Reactor Dynamics

Researcher: Captain Matthew Forsbacka, USAF
Sponsor: TOPAZ International Program, Albuquerque, New Mexico

The dynamic behavior of the TOPAZ II space nuclear reactor has not yet been fully characterized. This study uses reactor noise analysis methods to quantify the dynamic parameters of the TOPAZ II space nuclear reactor. Neutronic modeling of the core is accomplished with unit-cell calculations using GAMTEC and kinetics calculations using the HXPRT code derived from European Accident Code. The neutronic model will be coupled via response surface methodology with an empirically based thermal hydraulic model to yield the overall system dynamic model. The thermal hydraulic model will be constructed using pseudorandom noise techniques applied to data from a full scale reactor simulator in July/August 1994.

Ion Beam Analysis Of Ferrite Thin Films

Researcher: Associate Professor James R. Huddle
Sponsors: Naval Research Laboratory and Naval Academy Research Council (ONR)

Ferrite films of thickness ~ 0.5 μm have been grown on MgO substrates by Pulsed Laser Deposition (PLD). These ferrite films have stoichiometric composition $Mn_aZn_bFe_c O_d$. The purpose of the research program is to make films of varying compositions, to determine the composition of the films by proton-induced x-ray emission (PIXE) and Mossbauer spectroscopy, and to determine magnetic properties of the films by ferromagnetic resonance and vibrating sample magnetometry. While this work is part of a project of current interest at NRL, the ion beam analysis will be carried out using the facilities of the Naval Academy Tandem Accelerator Laboratory. In FY94, work involved modifying the software used for PIXE analysis in order to take advantage of a new x-ray detector which can detect oxygen x-rays and a feasibility study of using the Mossbauer spectroscopy to determine the ratio of ferrous (Fe^{2+}) to ferric (Fe^{3+}) ions.

Enhancement Of Hydrodynamic Flow Noise By The Regulation Of Air Bubbles in a Submerged Water Jet

Researcher: Professor Murray S. Korman
Sponsor: Office of Naval Research (Ocean Technology Program)

This experimental and theoretical research focuses on the dynamics of fluid turbulent flow when the flow is modified to become a two-phase flow consisting of water and air bubbles.

An experiment is performed to show that the near-field hydrodynamic flow noise (generated by a submerged turbulent water jet) is enhanced when the turbulent flow is modified to become a two-phase flow containing air bubbles. This experiment serves two purposes: (1) to determine if low frequency ocean noise is significantly generated by turbulent flows that contain bubble clouds, and (2) to test Crighton and Fowcs Williams theory of turbulent flow noise amplification - when bubbles are introduced into the flow [J. Fluid Mech. 1974] .

Pressure spectra, in the band 5Hz - 5000Hz, are measured using a digital spectrum analyzer from signals generated by a hydrophone placed at the axial and radial position (z=4D and r=4D) from the nozzle exit diam, D=0.635cm. An amplification factor $G = \int p^2_{two-phase} \, df / \int p^2_{single-phase} \, df$ is measured as a function of the gross void fraction β of the air bubbles. Here, β is found to be the ratio of gas volume flow rate (through the bubble-maker located at the nozzle entrance) to the water volume flow rate, Q_g/Q_w. The amplification G is measured as a function of by keeping Q_w constant (the nozzle velocity U=13.8m/s) and varying Q_g. Results show that $G \sim \beta^2$ and $G \sim 20$ at $\beta = 0.0065$. The mean-squared pressure fluctuation $\langle p^2 \rangle \equiv \int p^2_{two-phase} \, df$ is measured as a function of U by keeping Q_g fixed and varying Q_w. Results show that $\langle p^2 \rangle \sim U^m$ where m = 3.8, 2.2, 2.8 and 2.9 for Q_g = 0, 0.83, 1.43, 2.27 cm³/s, respectively.

Measurements of the Near-field Radiated Pressure Spectrum from a Submerged Turbulent Water Jet

Researchers: Midshipman 1/C Christopher Grillone Brian H. Scott, USN and Scott R. Swain
(Arundel High School, U.S. Naval Academy Anne Arundel Mentorship Program)
Adviser: Associate Professor Murray S. Korman
Sponsor: Naval Academy Research Council

Measurements of the near-field pressure spectrum are made from the turbulent shear flow generated by a submerged circular water jet of nozzle exit diam D = 0.635 cm. A small hydrophone is located at the point r = 4D , z = 4D, where r and z represent the respective radial and axial coordinates of the hydrophone position measured from the nozzle exit. Experiments involve measuring the ensembled averaged pressure spectra computed from the Fast Fourier Transforms of the pressure vs time signal that is recorded by a digital oscilloscope. From the collection of pressure spectra over the range of nozzle exit velocities, 7 m/s < V < 14.3 m/s, it is shown that the mean squared pressure $\langle p^2 \rangle$ is proportional to $V^{5.16}$. Further, the peak frequency f_p in the spectra is shown to increase with V and follows the relationship given by $f_p = (8.3/m) V - 9.6$ Hz. Spectra are curve fit successfully to the semi-empirical formula $a \, f^b / [1 + (c \, f)^c]^d$ where the a,b,c, and d parameters are determined over the range of nozzle exit velocities.

Enhancement of Hydrodynamic Flow Noise by the Regulation of Air Bubbles in a Turbulent Water Jet

Researcher: Associate Professor Murray S. Korman
Sponsor: National Center for Physical Acoustics, University of Mississippi

An experiment is performed to show that the near-field hydrodynamic flow noise generated by a submerged water jet is enhanced when the turbulent flow is modified to become a two-phase flow containing air bubbles. Pressure sprectra, in the band 5-5000 Hz, are measured using a digital spectral analyzer from signals generated by

a hydrophone placed at the axial and radial position (z = 4D and r = 4D) from the nozzle exit diameter, D = 0.635 cm. An amplification factor, $G = \dots p^2$two-phase $df / \dots p^2$single-phase df, is measured as a function of the gross void fraction $\int$ of the air bubbles. Here, $\int$ is found to be the ratio of the gas volume flow rate (through the bubblemaker located at the nozzle entrance) to the volume flow rate, Q_g / Q_w. The amplification G is measured as a function of $\int$ by keeping Q_w constant (the nozzle velocity U = 13.8 m/s) and varying Q_g. Results show that $G \gg \int^2$ and $G \gg 20$ at $\int = 0.0065$. The mean-squared pressure fluctuation $<p^2>$ _ ... p^2two-phase df is measured as a function of U by keeping Q_g fixed and varying Q_w. Results show that $<p^2> \gg U^m$, where m = 3.6, 4.3 and 4.7 for Q_g = 50, 86 and 136 sccm, respectively. This work is supported by NCPA.

Spatially Resolved Self-Pumping In Photorefractive Materials

Researcher: Associate Professor Steven R. Montgomery
Sponsor: Naval Academy Research Council (OMN)

Self pumping in photorefractive crystals is easily observed for continuous wave (CW) laser beams and is well documented. During a previous period of ONR sponsored funding it was found that self pumped phase conjugation is easily observed in Barium Stontium Potassium Sodium Niobate (BSKNN) when the input laser beam consists of pulses of about 120 picoseconds duration and 82 MHz repetition rate from a mode locked argon ion laser. In fact, the response is very similar to that from a CW beam. However, self pumping with trains of three picosecond pulses with the same repetition rate derived from the synchronously pumped dye laser produce only a very weak self pumped response from the crystal. It is the difference in behavior between the CW and pulsed cases that is the focus of this study. Rather than send in a train of single pulses a train of pulse pairs is formed, where the time between the pulse pairs is varied by moving a mirror in an optical delay line. The optical delay system has been constructed and interfaced to a Macintosh computer to adjust the delay time between the pulse pairs, rotate or translate the crystal, and record the signal level of the laser and phase conjugate beam. The delay system has been constructed and several trial data scans have been obtained.

Cooperative Photorefractive Beam Fanning In BSKNN

Researcher: Midshipman 1/C Michael P. Gallagher, USN
Adviser: Associate Professor Steven R. Montgomery
Sponsor: Trident Scholar Program

A multiline laser beam incident upon a Barium Strontium Potassium Sodium Niobate (BSKNN) crystal causes rings to form in the beam fan by means of cooperative photorefractive fanning between the different wavelengths. This novel case in which the input beam consists of two lines from an argon ion laser with independently controlled linear polarizations is examined and compared to the experimental data. The single line case has equal amounts of ordinary and extraordinary light. The expected rings are computed for each case, taking full account of the crystal birefringence. Applications of the rings to crystallography and cryptology are presented.

Optical Absorption And Electrical Relaxation in Alkaline Earth Fluorides Doped With Uranium

Researchers: Associate Professor Steven R. Montgomery,
Professor John J. Fontanella and Professor Mary C. Wintersgill
Sponsors: Naval Academy Research Council (OMN) and National Science Foundation

This work is concerned with optical absorption and electrical relaxation studies of calcium, barium, and strontium fluorides containing uranium up to the 0.5% doping level. The optical absorption spectra indicate the existence of both U^{4+} and U^{3+} ions but there is no evidence of any U^{2+} ions. Each sample exhibits two or more electrical relaxation peaks. By comparison with previous work on the alkaline earth fluorides containing known tetravalent and trivalent ions, some relaxations can be attributed to trivalent uranium and other to tetravalent uranium and thus both the electrical relaxation and optical absorption data reveal the presence of both U^{4+} and U^{3+} ions.

Update Physics Lab Software

Researcher: Professor David A. Nordling
Sponsor: Instructional Development Program

Since 1983, the Physics Department has incorporated microcomputers into the Physics laboratories. In 1989-1990, the department's computers underwent a major upgrade that incorporated expanded memory and a faster speed of the CPU. In 1991, the Physics Department began a program to upgrade the Physics Laboratory work station. This process involved replacing the previous microcomputers (Apple IIe) with a newer computer (Macintosh). Since that time, these newer computers have been installed in the laboratories used by students taking SP221, SP222, and SP226. Software has been developed for this new laboratory work station as well. Midshipmen in these courses have been using this newer work station during the academic years 1991-92 and 1992-93. This period has been used to help in ironing out bugs and making necessary improvements and changes in the software. Fifty-six computers and hardware were delivered in August 1993. This hardware along with associated software was installed on these 56 physics laboratory work stations in time for the beginning of the first semester.

Studies Of DThe Imaging and Ampliflication Of Low Intensity Light

Researcher: Professor Lawrence L. Tankersley
Sponsors: Naval Research Laboratory and
Naval Academy Research Council (ONR)

All work undertaken was in support of ongoing efforts at the Naval Research Laboratory in Code 5640. This year, studies of optical detection and analysis of debris in turbine engine lubrication fluids, imaging through turbid media and light amplification based on quantum processes such as stimulated Raman scattering were continued. Topics studied included low-light level amplification and imaging, quantum fluctuations and Raman amplifier noise, interactions of noise and signal field in amplifiers, amplifier dynamic effects - spatial and spectral gain narrowing, applications to biological studies and engine oil analysis, analysis of scattered light for image bearing components, pulse compression for time gated Raman scattering and development of support electronics.

As the academic year ends, the turbine engine oil analysis project is collecting baseline imaging data on a J79 engine at Lakehurst, New Jersey.

Electrical Properties Of Polymers

Researchers: Professor Mary C. Wintersgill and
Professor John J. Fontanella
Sponsor: DuPont de Nemours, Co.

The audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for various types of polymers. Several new relaxations were observed and the activation parameters for each were determined.

Fragmentation Of Isovector Quadrupole Vibrations In Cerium-142

Researchers: Associate Professor Jeffrey R. Vanhoy,
Midshipman 1/C B.T. Meehan, USN, Midshipman 2/C B.H. Benedict, USN,
Lieutenant Junior Grade G.S. Schoenthal, USN
Ensign Bryan Haas, USN, Ensign Sally F Hicks, USN
Sponsor: National Science Foundation

Studying the properties of low-lying nuclear states reveals much information about the behavior of nuclear matter. In the heavier nuclei where many nucleons are involved, it is not possible to keep track of the individual particles and one is forced to use almost exclusively the collective model description. The collective model treats the nucleus as a fluid undergoing vibrations and rotations.

But in fact, the nucleus is composed of neutron and protons -- distinguishable particles, so the nucleus should be considered as a mixture of two separate fluids in certain situations. There are several normal modes of oscillation which could occur. The exotic oscillations are commonly referred to as mixed-symmetry states or isovector states. As in many systems undergoing oscillations, it becomes apparent that the actual motion of the nucleus is not in pure normal modes. The extent of the fragmentation of isovector vibrations has not been measured in spherical nuclei.

The excited levels of ^{142}Ce and the electromagnetic transitions between these levels have been studied using the $(n,n'\gamma)$ reaction. Excitation functions, angular distributions, and Doppler shifts were measured for observed gamma rays for levels up to an excitation energy of 3.3 MeV; multipole mixing and branching ratios were deduced. Many of the features of the nucleus can be described in terms of an anharmonic vibrational picture. The 2+ and 3+ mixed symmetry strength is fragmented among neighboring levels. In the 2+ case, there is experimental evidence of fragmentation thru the strong M1s. In the 3+ case, mixed symmetry strength does not manifest itself in terms of strong M1s, but it presence is only implied thru Interacting Boson Model-2 (IBM2) calculations. Some features, such as the ground state decays of higher lying 2+ states lie outside the limits of the IBM2 model, and appear to require a more "particle" degrees of freedom.

Stability And Relaxation In Nonlinear Optical Polymers

Researcher: Professor Mary C. Wintersgill
Sponsor: Office of Naval Research

Photonics is increasingly being used or proposed for use in a variety of applications including high speed fiber optic communications, computer interconnects, data distribution networks, fiber optic sensor systems, phased array radar, inertial guidance, and underwater communications. Many of these systems either require or would benefit from nonlinear optical (NLO) materials that can be used in devices to modulate the amplitude and phase of light. Types of nonlinear polymers' potential advantages over conventional inorganic NLO crystals are

discussed, as well as a central technical issue in the use of nonlinear polymers for device applications - decay of the nonlinear optical effects with time and with temperature. The relaxation of the orientational order, induced by electric field poling to enable nonzero second-order NLO effects, varies from polymer to polymer with decay constants ranging from hours to years. As a direct probe of the NLO decay, data is presented on the second harmonic generation measurements as a function of increasing temperature. These results are compared to

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dielectric relaxation measurements, which are a linear electrical probe of orientation effects in the dielectric constant. Relaxation mechanisms are discussed.

Independent Research

A Southern Hemisphere Survey
Of Ti II In The Galactic Disk

Researcher: Professor C. Elise Albert

During a recent study of interstellar Ti II absorption toward southern hemisphere halo stars (Albert et al., 1994, in press), both Ti II and the ultraviolet doublet of Na I were observed toward 12 bright reddened southern stars in the galactic disk. The ultraviolet sodium lines are particularly interesting since they do not suffer the extreme saturation that affects the well-studied optical doublet. Although the galactic disk has been surveyed thoroughly in the northern hemisphere, the physical characteristics of interstellar gas in the southern hemisphere are still unstudied. A project is begun to obtain high signal-to-noise data toward several dozen bright stars to provide a probe of the neutral phase of the interstellar medium in the southern sky.

Projectile K-Auger Electron Spectroscopy
In Fast Ion-Atom Collisions

Researcher: Assistant Professor John M. Anthony

The energy and intensity of K-Auger electrons emitted by projectile ions are measured following collisions with atomic or molecular gas targets. Due to kinematic broadening effects, Auger lines arising from the decay of the projectile electron cloud can lead to a severe degradation of resolution and an electron spectrometer designed to minimize these effects was used. The high energy resolution projectile electron spectrometer (HRPES) which was designed and built by the atomic collisions group at the University of North Carolina at Chapel Hill was used in experiments performed at the Oak Ridge National Lab (ONRL). Also a high resolution zero degree observation angle tandem electron spectrometer was used for experiments conducted at Kansas State University's MacDonald Lab.

The experiments so far have concentrated on measuring transition energies and production cross sections for doubly ionized (4-electron) carbon ions in the 3 to 20 Mev energy range. Some data was also taken for two

1989 electron carbon ions as well. Work during the summer of and through the 1989-90 academic year was performed at the Oak Ridge National Lab EN tandem Van de Graff accelerator facility. A great deal of advice and technical support was given by the ORNL atomic collision group. In the summer of 1990, the atomic collision group headed by Pat Richard at KSU using their new 0 degree spectrometer became available.

So far, measurements include the $1s^2 2s2p \, ^3P$ metastable fraction in the incident 4-electron (or Be like) carbon beam over a 3 to 15 MeV energy range. Work is also in progress to compare measured Auger production cross sections, for certain transitions, to theoretical calculations for excitation by the electron-electron anti-screening interaction.

Also, a computer program has been written and is now being tested for modeling the lens effect of the radial deceleration field used in the ORNL experiments.

PIXE Analysis Of Artifacts From St. Mary's City

Researcher: Professor Francis D. Correll
Professor Douglas W. Edsall

A cooperative effort between Historic St. Mary's City (HSMC) and the U.S. Naval Academy to perform trace-element analysis of selected archaeological materials has been begun. Samples of several types of locally-produced colonial pottery, clay tobacco pipes, and ceramic building materials have been analyzed using external-beam proton-induced x-ray emissions (PIXE) spectroscopy. Concentrations of elements with atomic numbers ranging from 19(K) to 82(Pb) have been determined. Standard reference materials used for calibration were NBS brick clay and USGS marine mud.

Preliminary results indicate that in-air PIXE may have great utility in archaeological studies. It has been possible to differentiate between the products of three colonial potters and to substantiate previous identifications of pottery sherds attributed to them; to establish trace-element comparisons between Old-World and colonial sherds; to differentiate between local and distant sources of clay for smoking pipes, and to relate these differences to hypothesized source areas based upon decorative styles, and to address the similarities and differences between the clays used in the manufacture of pottery, pipes, and bricks.

Trace Element Concentration In Water, Biological, And Geological Samples From The Annapolis Area, Chesapeake Bay

Researcher: Professor Douglas W. Edsall

The U.S. Naval Academy's 2.7 MeV Proton Induced X-Ray Emission (PIXE) accelerator was utilized to analyze the trace element concentrations in samples from the Severn River and the nearby Chesapeake Bay. Concentrations of heavy metals in the ppm range have been determined for: water samples, surficial bottom sedi-

ments, the skeletal and soft tissue of fish, and crab and oyster specimens. Preliminary results suggest that a relationship exists between the elemental concentrations in these three media. With this data begins the question of whether or not there is a toxic problem in the Bay and its tributaries.

Differentiation Of 17th Century Baker, Jones, And Rogers Pottery From HSMC By Their Trace Element Concentrations As Measured By PIXE

Researcher: Professor Douglas W. Edsall

A suite of 17th Century pottery sherds attributed to Baker, Jones, and Rogers were analyzed with the Naval Academy's 2.7 MeV proton-induced x-ray emission (PIXE) instrument. Concentrations of elements between K and Zr were determined. Statistical tests show similarities between pottery made by these potters from local southern Maryland clay deposits. Major differences in

the work of these three potters occur in the trace element concentrations in their glazes.

This technique seems to be useful in similar archaeological studies. Determination of trace element concentrations and their variability in 17th Century pottery is continuing. Samples of pottery are being sought for comparison and inclusion in a data bank.

Differentiation Of 17th Century Smoking Pipes From Historic St. Mary's City By Their Trace Element Concentrations As Measured By PIXE

Researcher: Professor Douglas W. Edsall

A suite of clay smoking pipes, both of local and Indian origin, were analyzed with the Naval Academy's 2.7 MeV proton-induced x-ray emission (PIXE) instrument. Concentrations of elements between K and Zr were determined. Statistical tests enable differentiation between pipes make from local southern Maryland clay deposits and those fashioned from non-local clays and brought to St. Mary's City.

Elemental variations of greatest interest are: Fe, Mn, Co, Ni, Cu, and Zn. This analytical method appears to have utility in similar archaeological studies. Determination of trace element concentrations and their variability in smoking pipes is continuing. Samples of "local" clay deposits, utilized by 17th Century inhabitants, are being sought for comparison purposes and inclusion in our data bank.

Trace Element Concentrations And Variability In 17th Century Building Material From Historic St. Mary's City

Researcher: Professor Douglas W. Edsall

A suite of bricks from selected sites in Historic St. Mary's City were analyzed by the Naval Academy's 2.7 MeV proton-induced x-ray emission (PIXE). Concentrations of elements between K and Zr were measured at multiple sites for each brick specimen to determine internal variability. Elemental concentrations were compared with "local" 17th Century pottery sherd and pipe specimens. Results confirm use of local clays in brick manufacture when compared with sherds and pipes. Variations within individual bricks is still under investigation.

Trace Element Sinks In the Chesapeake Bay Concentrations In the Water, Life, And Sediments

Researcher: Professor Douglas W. Edsall

The U.S. Naval Academy's 2.7 MeV Proton Induced X-Ray Emission (PIXE) accelerator was utilized to analyze the trace element concentrations in samples of water, biological, and geological materials. Concentrations of heavy metals in the ppm range have been previously reported for sediments and the hard and soft tissue of fish, crab, and oyster specimens. To expand upon the original work, water samples have been analyzed to determine the elemental spectrum of various Bay environments. Depending upon the detection limits, applications in identification and location of pollutant sources and dispersal pathways and detection of moored objects via shedding of metal ions or the byproducts of biofouling can be seen. Environmental spectrum signatures are being sought for specific objects and locations.

Theory Of Jet-Pipe Oscillation

Researcher: Professor Samuel A. Elder

Work has continued on refinements of a theory of self-sustained jet pipe oscillation modeled as an oscillating fluid-diaphragm, with a view to extending the accuracy of root-locus calculations for off-resonant values. A key parameter appears to be the accurate determination of the relative magnitudes of the series and parallel contributions to jet-drive. At present, only an order of magnitude estimate is possible for the series term due to the difficulty in integrating the force-density over the converging-diverging field at the mouth of the pipe. This affects the accuracy in estimating the amplitude of oscillation at resonance. More importantly it has a

profound effect on off-resonant predictions due to the fact that the imaginary term in the series drive force varies oppositely in phase to that associated with parallel drive, so that the approach to resonance is quite different depending on which term is dominant. A completed

article for the Journal of the Acoustical Society of America is being reviewed for publication. New experimental tests, using a towed underwater test cavity, are contemplated to settle some of the questions raised by theoretical considerations.

Magnetospheric Physics

Researcher: Associate Professor Irene M. Engle

There are several projects which have been thought about or worked upon intermittently with progress during the past year.

From first principles, a representation of the Jovian magnetosphere was modelled during a semi-inflated state, as observed during the Voyager II flyby. A paper was written to fit the magnetometer data from the Ulysses encounter with Jupiter. A presentation of a revised model characteristic of the Ulysses flyby was made by a co-author at a meeting of the American Geophysical Union.

A new look at the Mercury magnetospheric field, in response to a recently published review on Mercury, contains some conclusions which are not supported by this investigator's experience. Other investigators are interested in obtaining time dependent configuration

modeling for analysis of some more recently observed photoionization of heavy ions near the disc of Mercury.

Observed temporal variations of magnetospheric configurations were related to the proximate causes and consequential phenomena. Investigations of the mechanisms for transport of particles, momenta, and energy were related to the above phenomena.

From first principles, a representation of the Saturnian magnetosphere was modelled as observed during the Pioneer 11 and Voyager I and II flybys. The work is in support of the charged particle investigations of the future Cassini mission, which is to place an orbiter about Saturn. A paper written jointly with Sylvestre Maurice has recently been accepted for publication by the Journal of Geophysical Research. Three presentations based upon the work have been made in Europe.

Project Moon '93

Researcher: Associate Professor James R. Huddle

As has been pointed out by L. Krumenaker (Sky & Telescope 84 (6), December 1992, p. 704), it is possible to measure the diameter of the moon and its distance from Earth by making simple observations of the Earth's shadow as it falls on the moon during a lunar eclipse. As an advanced physics lab experiment, the 29 November 1993 total lunar eclipse was observed by thirteen students using 3 1/2 inch Questar telescopes, each observer making sketches of the shadow on a lunar chart. From

these data, the ratio of the shadow diameter to the moon's diameter were determined. This result, along with a simple measurement of the geometry of the shadow, were used to determine the distance to the moon and its diameter, corrections being made for several systematic errors (each of the order of 1%) in Krumenaker's method. There will be only three more lunar eclipses (two total and one partial) visible from the Annapolis area until the year 2000.

Nonlinear Scattering of Crossed Focussed Sound Beams in the Presence of Turbulence

Researcher: Professor Murray S. Korman

The interaction of two, mutually perpendicular crossed continuous wave ultrasonic beams, overlapping at a common focal point and interacting in the presence of turbulence in water is demonstrated by the detection of the far-field radiated sum frequency component. This scattered sum frequency pressure p_+ exhibits a time

averaged Doppler shift and frequency broadening due to scattering from turbulent eddies in the overlap region that are not stationary in time.

The angular dependence of the frequency spectrum of the scattered sound makes it possible to measure the mean flow velocity and the so-called higher order turbu-

lent velocity correlations. The audience will be able to hear the frequency demodulation of the sum frequency signal by using an FM radio receiver. The radio receiver is coupled to the acoustic receiving transducer and is tuned to detect wideband FM centered on $f_+ = f_1 + f$.

Here, $f_1 = 2.1$ MHz and $f_2 = 1.9$ MHz are the respective primary frequencies. The demodulation signal will change as the scattering angle is changed or the overlap region is moved to a new point in the turbulent flow which is generated by a submerged jet.

Determination of Turbulent Velocities by Nonlinear Acoustic Scattering

Researcher: Professor Murray S. Korman
and Ensign James E. Parker III, USN

The nonlinear interaction of two, mutually perpendicular crossed ultrasonic beams, overlapping in the presence of turbulence, generates a scattered sum frequency component that radiates outside the interaction region. In the absence of turbulence, virtually no scattered sum frequency component exists outside the interaction region. A theoretical investigation is reported which relates the shape of the ensembled averaged scattered sum frequency intensity spectrum, $I_+(\Sigma, \alpha_*)$, (which exhibits a Doppler shift, frequency broadening, skewness and kurtosis) to the scattering angle α_*, incident and scattered wave vectors (where $K_+ = k_s - [k_1 + k_2]$) and statistical properties of the turbulent velocity field U. The n spectral moments

$< (K_+ \bullet U)^n > \_ \ldots I_+(\Sigma, \alpha_*) (\Sigma - <\Sigma>)^n d\Sigma$ (obtained from experiment) are used to evaluate turbulent velocity correlations like $< U_x U_y >$, where $n = 2$. The scattering geometry involves rotating the axes of the transmitting crossed beams (which are always perpendicular to each other) in the plane containing the jet and receiver axes. Angle α_* is measured between the ray bisecting the transmitting axes and the stationary receiver axis. The crossed beams are focused and overlap at the common focal point. Spectral moments, obtained from scanning the overlap region across the jet, are used to predict velocity correlations across the width of the jet with good spatial resolution.

Nuclear Magnetic Resonance In Polymers

Researcher: Professor Donald J. Treacy

In collaboration with Warminster Naval Air Station, Nuclear Magnetic Resonance was considered to determine the relaxation mechanism for several polymers exhibiting non-linear optical behavior, specifically frequency doubling. This behavior is exhibited after the polymer has been electrically polarized. The efficiency

of frequency doubling decreases with time after the electrical polarization. The samples supplied by the sponsor were substantially too small to conduct experiments. The equipment is in place to conduct the appropriate experiments if samples are provided.

Research Course Projects

A CCD Camera System For The Class Of 1941 Telescope

Researcher: Midshipman 1/C Jason Hoepper, USN
Adviser: Professor C. E. Albert

The goal of this project was to install and calibrate a charge coupled device (CCD) imaging system on the 7 3/4" Alvan Clark retracting telescope in the Class of 1941 Observatory. The CCD camera takes multiple short exposures, ranging from 0.01 to 10 seconds, which

are displayed on a monitor in real time. Short exposures are less affected by turbulence in the Earth's atmosphere and can be combined and processed to produce images with enhanced resolution. The entire system is computer controlled.

Particle-induced X-Ray Emission (PIXE) Analysis of Oysters From Selected Chesapeake Bay Locations

Research: Midshipman 1/C Brian Mecklenburg, USN
Adviser: Professor Francis D. Correll

Oyster tissue and shells from several locations in the Chesapeake Bay area have been studied using proton-induced x-ray emission (PIXE) spectroscopy. Whole oysters, harvested from the South River, the Miles River, and the Pocomoke River, were obtained from the Maryland Department of the Environment. They were dissected and their adductor muscles and gills were vacuum dried. Previously freeze-dried tissue specimens from oysters harvested in the Tred Avon River, were obtained from the Foundation for Advanced Research in the Medical Sciences. Tissues and shells were bombarded in air with 1.5-MeV protons from the Naval Academy Tandem Accelerator, and the resulting characteristic x-rays were measured using a lithium-drifted silicon detector. Concentration values were derived from the x-ray yields using the computer program GUPIX and an oyster tissue standard reference material obtained from the National Institute of Standards and Technolgy.

Seven elements (K, Ca, Mn, Fe, Cu, Zn, and Sr) were detected in the shells. Higher concentrations of Cu, Fe, and Zn were found in gill tissue than in muscle tissue. Conversely, higher concentrations of Ti are present in the muscles than in the gills. Samples from the South River seemed to contain much higher concentrations of Ni than those from the other locations. Shells from the South River oysters contained unusually high concentrations of Mn and Zn.

Additional samples should be obtained and analyzed to confirm the significance of these results.

Multiparameter Data Acquisition Using Kmax

Researcher: Midshipman 1/C Bernard T. Meehan, USN
Advisers: Associate Professor Jeffrey R. Vanhoy
Professor Francis D. Correll

A new programming environment, Kmax™, for data acquisition and control was acquired and installed on several fast Macintosh computers in the accelerator laboratory and the laboratory of the nuclear physics course, SP434. Kmax allows a user to control a very large variety of CAMAC devices, including Analog to Digital Converters (ADCs) and scalers, both of which receive data from the X-ray, gamma-ray, and particle detectors in the laboratories. Kmax also permits low-level, on-line data sorting, processing, and display. Routines (scripts) were written to replace and modernize the existing data acquisition systems in the laboratories. One script permits simultaneous data acquisition using three ADCs, two of which may be operated in coincidence mode. Another permits displaying K- and L-x-ray "markers" to assist in analyzing proton-induced x-ray emission (PIXE) spectra. These scripts were tested in the SP434 laboratory.

PIXE Analysis Of Race Metals In The St. Mary's River

Researcher: Midshipman 1/C Brian Pummill, USN
Advisors: Professor Douglas W. Edsall

The increase of trace metal pollution in the marine environment has created a heightened concern among many prominent scientists. The activities of human beings are considered to be the major contributors of this damaging form of pollution in the Chesapeake Bay region. The research which I conducted involved the analysis of arsenic and copper concentrations in the blisters of oyster shells. Six oyster shell samples were collected from the St. May's River and dated from 1600 to 1860. The process of Proton Induced X-ray Emission (PIXE) was used to determine the relative concentration of the two trace metals with time. My results support the hypothesis that man has contributed to the increase of trace metals in the St. Mary's River. However, the data

clearly shows that man is not the sole cause; concentrations of copper were on an upward trend before 1643, when European settlers arrived in this area. Nevertheless, the concentrations of both arsenic and copper dramatically increased in the samples which were dated after 1820; a time in which industry and agriculture were beginning to develop in this region.

PIXIE Analysis Of Sediment Cores From Two Stations In The Severn River

Researchers: Midshipman 1/C Brian Rivenbark, USN
Midshipman 1/C Daniel Turnbow, USN
Adviser: Professor Douglas W. Edsall

Sediment cores were taken at two locations on the lower Severn River and analyzed in the proton-induced x-ray emission (PIXE) lab located at the Naval Academy. By analyzing the two cores at varying depths, the researchers hope to show a gradient in trace element concentration. If a gradient can be established in one or more elements, the researchers can determine the mechanism responsible for this gradient. Also, an attempt to show that the concentration of the elements suspended in the sediment have been decreasing due to recent efforts to clean up the environment will be made. If an element is observed to either appear or disappear at a given depth in the core, the researchers will try to correlate any records of its introduction or removal from the environment (such as use of lead based marine paints) in order to date the sediment and possibly determine the sedimentation rate.

Electrical Properties of NAFION

Researcher: Midshipman 1/C Roger A. Hardy, USN
Adviser: Professor John J. Fontanella

The purpose of this project was to measure the electrical conductivity of NAFION under various conditions including different values of relative humidity. NAFION is an important, polymeric ion exchange membrane being considered for use in methanol fuel cells. In order to achieve this goal, several controlled atmosphere chambers were constructed and equipment for both electrical and dimensional measurements was assembled. Measurements were completed for two humidities on NAFION samples with three different molecular weights.

Computer Graphic Simulations of Microscopic Particle Collisions For Determining Macroscopic Thermodynamics Along A Path

Researcher: Midshipman 2/C Devin P. Espindle, USN
Adviser: Professor Murray S. Korman

The heat absorbed by an ideal monatomic gas during an isothermal expansion (when a piston slowly moves from volume point V_1 to V_2 in a cylinder) is a standard problem in thermodynamics. Students taking SP226, Heat, Light, and Sound, learn that the process involves an understanding of the kinetic energy loss that a gas molecule makes with the slowly moving piston "called the bunt". The process also involves a drop in internal energy of the gas as a collection, which leads to a slight drop in temperature of the gas and the transfer of heat from the reservoir to the gas until an equilibrium temperature is reached. This problem is modeled in two dimensions on a computer. The collisions involve N elastic scatterers that each have a cross-section of radius r_o. The heat reservoir is modeled by molecules having a random distribution of velocities at the wall boundary which is in contact with the gas. The piston is modeled as a wall which moves at the speed V_{wall}. Thermodynamic calculations involving work, heat and entropy are attempted for the model system. Adiabatic and free expansions are also

simulated and compared with the well-known theoretical results. Work is extended to cover collisions involving intermolecular potentials.

Publications

CORRELL, Francis D. and Douglas W. EDSALL, Professors, "Sentinel Species: Some Biologically Active Trace Metals in the Livers of Oyster Toadfish (Opsanus tau)," Proceedings of the 1994 Coastal Oceans Conference, (1994), 1993-2008.

Oyster toadfish (Opsanus tau) are a resident part of the estuarine benthic food web from the New England states to Florida in the U.S.A. They are a sentinel species with the potential to extract toxic environmental trace metals. To test this hypothesis, the authors are studying toadfish resident in the Chesapeake Bay near Annapolis, Maryland. This area is away from any direct industrial or commercial effluents carrying trace metals, but has concentrations of trace metals in the benthic sediments. Since the toadfish is a resident, non-migratory benthic predator, we feel it is useful in studying trace metal contamination and eventually modeling metal movements in a biological system. This study concentrates on trace metals found in the physiologically important organ, the liver. This study uses a proton-induced x-ray emissions (PIXE) system to analyze for the trace metals. The PIXE system allows a rapid method to determine trace metal types, concentrations and an archiving method for samples. Present analyses of various size toadfish show that the livers contained concentrations of chromium (5.9-51.7 mg/L), copper (3.3-26.0 mg/L), and zinc (8.6-29.9 mg/L). The trace metal amounts vary as a function of the size, age, and sex of the fish. Copper and chromium concentrations deplete with age after the reproductive phase, while zinc concentrations increase. Generally, the trace metals have an accumulation pattern of chromium>zinc>copper that is different from the zinc>copper> chromium in the sediments of the Atlantic and Gulf coasts of the U.S. Thus the life history of the animal appears as an important factor in trace metal accumulation. This leads to postulating a conceptual model for trace metal flow through this biological system. Although establishing that trace metal concentrations appear linked to the life history stage of the toadfish, the authors plan further work on the impact as well as protective mechanisms.

FONTANELLA, John J., and Mary C. WINTERSGILL, Professors, "Electrical Impedance Studies of Acid Form NAFION membranes." *Solid State Ionics 66*, (1993), 1-4.

Electrical conductivity/dielectric relaxation studies of acid-form NAFION-117 have been carried out at frequencies from 10 to 10^8 Hz. By direct measurement, it is shown that when "standard" two terminal measurements are made across the thickness of a 0.18 mm film, it is necessary to use frequencies in excess of 10^7 Hz in order to observe the bulk conductivity of the sample. As a consequence, previous reports of a power law dependence for the electrical conductivity are not associated with the bulk electrical conductivity but rather are due to electrode effects and space charge. As confirmation, it is shown that by changing the geometry of the electrodes, the low frequency electrical response of the material is significantly changed.

FONTANELLA, John J. And Mary C. WINTERSGILL, Professors, "Complex Impedance, DSC and Lithium-7 NMR studies of Poly (propylene oxide) complexed with $LiN(SO_2CF_3)$ and with $LiAsF_6$." *Solid State Ionics, 67* (1994), 257-262.

Complex impedance/electrical conductivity, differential scanning calorimetry and Li nuclear magnetic resonance measurements on poly (propylene oxide) complexed with two lithium salts $LiN(SO_2CF_3)_2$ and $LiAsF$, with compositions of eight ether oxygens per lithium, are reported. Ionic mobility, as probed by NMR linewidth and spin-lattice relaxation measurements, is strongly coupled to polymer segmental motion above T_g. The electrical conductivity for PPO_8LiAsF_6 is about an order of magnitude smaller than for $PPO_8LiN(SO_2CF_3)_2$. This is a consequence of the higher glass transition for PPO_8LiAsF_6. The stretched exponential parameter β, obtained in fits to electric modulus data, was found to be about 0.51 for $PPO_8LiN(SO_2CF_3)_2$ and 0.57 for PPO_8LiAsF_6.

FONTANELLA, John J. And Mary C. WINTERSGILL, Professors, "Optical Absorption and Electrical Relaxation in Alkaline Earth Fluorides doped with

Uranium," *Journal of Physics and Chemistry of Solids,* *55* (1994), 201-206.

This work is concerned with optical absorption and electrical relaxation studies of calcium, barium, and strontium fluorides containing uranium up to the 0.5% doping level. The optical absorption spectra indicate the existence of both U^{4+} and U^{3+} ions but there is no evidence of any U^{2+} ions. Each sample exhibits two or more electrical relaxation peaks. By comparison with previous work on the alkaline earth fluorides containing known tetravalent and trivalent ions, some relaxations can be attributed to trivalent uranium and others to tetravalent uranium and thus both the electrical relaxation and optical absorption data reveal the presence of both U^{4+} and U^{3+} ions.

KORMAN, Murray S., Professor, "Enhancement of Hydrodynamic Flow Noise by the Regulation of Air Bubbles in a Turbulent Water Jet," Ocean Technology 1993 Program, Office of Naval Research, ONR 32194-10, (April 1994), 200-202.

Pressure spectra, in the band 5Hz - 5000Hz, are measured using a digital spectrum analyzer from signals generated by a hydrophone placed at the axial and radial position (z=4D and r=4D) from the nozzle exit diam, D=0.635cm. An amplification factor $G = \int p^2_{two-phase} \, df / \int p2_{single-phase} \, df$ is measured as a function of the gross void fraction β of the air bubbles. Here, β is found to be the ratio of gas volume flow rate (through the bubble-maker located at the nozzle entrance) to the water volume flow rate, Q_g/Q_w. The amplification G is measured as a function of β by keeping Q_w constant (the nozzle velocity U=13.8m/s) and varying Q_g. Results show that $G \sim \beta^2$ and $G \sim 20$ at $\beta = 0.0065$. The mean-squared pressure fluctuation $<p^2> \equiv \int p2_{two-phase} \, df$ is measured as a function of U by keeping Q_g fixed and varying Q. Results show that $<p^2> \sim U^m$ where m = 3.8, 2.2, 2.8 and 2.9 for Q_g = 0, 0.83, 1.43, 2.27 cm³/s, respectively.

MONTGOMERY, Steven R., Associate Professor, "Enhancing the Photorefractive Effect," *Optics Communications 101,* (5,6), 1 September 1993, 397.

The transient response for beam fanning in photorefractive tungsten bronze crystals with an applied electric field was studied. Response times on the order of 1 ms for an incident power of 1 mW were observed for incident beams focused to a 30 mm diameter in the crystal. This improved response time was accomplished without the significant reduction in the magnitude of the

FONTANELLA, John J. And Mary C. WINTERSGILL, Professors, "Electrical Relaxation of Dimers in Rare Earth-doped Calcium Fluoride," *Journal of the Physics and Chemistry of Solids, 54* (1993), 513-516.

Audio frequency of complex impedance measurements has been carried out over the temperature range 310-510K on samples of calcium fluoride containing 0.1 mol% of either lanthanum or cerium. Consequently, the R_{IV} relaxation has been studied. The activation energies are found to be 1.049 and 1.089 eV for cerium and lanthanum, respectively. This relaxation is due to reorientation of a rare earth dimer. The structure of the defect site is discussed.

photorefractive effect normally observed when using focused beams.

MOSCA, Eugene P., Associate Professor, co-author, "Implications of Using the CASTLE Model," *The Physics Teacher,* 31 (6) (September 1993), 357-359.

The CASTLE Project model for electrical conduction is discussed. It is suggested that there are features of the model which will present obstacles to a deeper understanding of the physics of circuits.

TANKERSLEY, Lawrence L., Professor, co-author, "Time-Gated Imaging Through Dense Scatterers with a Raman Amplifier," *Applied Optics 32,* 20 December 1993, 7425-7433.

A time-gated Raman amplifier has been used to detect a bar chart hidden by a strongly scattering material. The time gating was provided by a frequency-doubled Nd:YAG pump laser having a pulse duration of 30 ps. The authors have amplified and detected images with resolved structures smaller that 125 μm through suspensions of polystyrene spheres and nondairy creamer for light extinction factors of up to e^{33}. The Raman amplifier system has been shown to produce images under conditions in which the scattering medium was sufficiently dense that an image could not be detected on either a streak camera or by integration on a sensitive, low-noise camera.

VANHOY, Jeffrey R., Associate Professor, co-author, "Decay Properties and Lifetimes of States in ^{144}Sm from (n,n'γ) Reaction Studies", *Nuclear Physics A* 560, (1993), 633.

An extensive investigation of ^{144}Sm has been carried out with the (n,n'γ) reaction. Gamma-ray excitation function and angular distribution measurements were performed at neutron energies up to 4.3 MeV. Many new levels have been established and characterized, and the assignments of several previously known states have been clarified. Level lifetimes were measured following the inelastic neutron-scattering reaction by observing the Doppler shifts of de-exciting γ-rays, and reduced transition rates have been inferred. Recent shell model calculations were found to describe the ^{144}Sm level scheme very well up to 3.2 MeV. A large number of relatively fast E1 transitions were observed.

VANHOY, Jeffrey R., Associate Professor, co-author, "^{127}Xe Spectroscopy from Compound (p,nγ) Cross Sections", In Proceedings of the Franklin Symposium in Celebration of the Discovery of the Neutrino, Edited by C.E. Lane and R.I. Steinberg. Singapore: World Scientific, (1993), 181.

Measurements of ^{127}I(p,nγ) angular distributions have been made at an incident proton energy of 6.2 MeV. The non-selectivity of the low-energy (p,n) reaction allows observation of all states with J ≤ 9/2 below 1.3 MeV excitation. Spin assignments and gamma ray branchings are clarified for several states of interest for neutrino capture of ^{127}I.

VANHOY, Jeffrey R., Associate Professor, co-author, "Acquired Polarization in k∘I PNC Experiments", *Zeitschrift für Physik A* 345 (1993), 249.

Parity non-conserving neutron transmission asymmetries have been calculated for unpolarized beams on polarized targets. As the neutron beam propagates through a polarized target, some components are preferentially absorbed. This acquired polarization complicates the interpretation of transmission measurements. The authors extend the analysis of Postma et al. to include parity mixing in the neutron resonances and emphasize the importance of the nuclear resonance spectroscopy. The relative importance of the acquired polarization contribution is determined by the spectroscopic parameters.

WINTERSGILL, Mary C. And John J. FONTANELLA, Professors, "Internal Motions in Polylactide and Related Polymers," *Macromolecules, 26* (1993) 5084-5087.

Polyactide (-95% L-isomer), polyglycolide, and a 1:1 copolymer were studied by differential scanning calorimetry, dynamic mechanical analysis, and dielectric relaxation. In addition to the previously known glass transitions, all of these polymers exhibit a relaxation similar to the B-relaxation which occurs in many other materials, This relaxation which occurs near 200K at 1kHz, is attributed to noncooperative local motions. Another new relaxation near 15K was found in polyactide and the copolymer but not in polyglycolide and hence is attributed to motions of the side methyl groups. The effect of increased humidity on polyactide was also investigated. The weight gain of the samples depends strongly on the relative humidity and continues over extended periods of time. Changes in the dielectric relaxation spectra were consistent with substantial decreases in molecular weight.

WINTERSGILL, Mary C. and John J. FONTANELLA, Professors, "Electrical Relaxation in In-Situ Dried Acid-Form NAFION" *Journal of Polymer Science, 32* (1994) 501-507.

Electrical relaxation studies have been carried out on dried, acid-form NAFION 117 (copolymer of tetrafluoroethylene and perfluoro 3, 6-dioxa-4-methyl-7-octenesulfonic acid and which has an equivalent weight of 1100). Significant electrical conductivity is found and the data are found to be non-Arrhenius. The results are converted to the electrical modulus representation and a conductivity relaxation is observed for the peak position. Finally, at low temperatures, a new dielectric relaxation peak is found which has an activation enthalpy of about 0.57 eV (13 Kcal/mol). This relaxation is analogous to the g-relaxation observed in mechanical relaxation studies.

WINTERSGILL, Mary C. and John J. FONTANELLA, Professors, "Effect of Hydrofluorocarbons on the Low-Temperature Dielectric Properties of Poly(tetrafluoroethylene)." *Macromolecules, 27* (1994), 610-611.

In a recent paper, the effects of absorbed chemicals on the dielectric properties of poly(tetrafluoroethylene) (PTFE) were described. The "guest" molecules used in that study were chloroform and fluorocarbon -113(1,1,2-trichloro-1,2,2-trifluoroethane). As chlorofluorocarbons are phased out, they are frequently replaced by hydrofluorocarbons. It was of interest to determine to what extent these compounds would be absorbed by PTFE and how they would affect the dielectric properties. It is known that the presence of hydrogen in organic molecules tends to greatly reduce absorption by fluoropolymers, even when the solubility parameters are similar.

Presentations

ALBERT, C. Elise., Associate Professor, "Southern Hemisphere Observations of Interstellar Ti II," The American Astronomical Society, Berkeley, California, 8 June 1993.

ALBERT, C. Elise., Associate Professor, "Interstellar Ti II in the Galactic Halo," Workshop on Halo Gas, Space Telescope Science Institute, Baltimore, Maryland, 13 August 1993.

BRILL, Donald W., Professor, "Identification of cylindrical shells with sets of reinforcing ribs by their Bragg diffraction grating patterns," SPIE (the International Society for Optical Engineering) International Symposium on Optical Engineering in Aerospace Sensing, Orlando, Florida, 4-8 April 1994.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Differentiation of Colonial Baker, Jones and Rogers pottery from Historic St. Mary's City by their trace element concentrations as measured by PIXE," 1993 Annual Meeting, Geological Society of America, Boston, Massachusetts, 25 October 1993.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Differentiation of 17th Century Tobacco Pipes from Historic St. Mary's City by their trace element concentrations as measured by PIXE," 1993 Annual Meeting, Geological Society of America, Boston, Massachusetts, 25 October 1993.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Heavy Metal Concentrations in selected Chesapeake Bay Marine Life, especially oysters," 1993 Annual Meeting, Geological Society of America, Boston, Massachusetts, 28 October 1993.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Concentrations and Variability in 17th Century Building Materials from Historic St. Mary's City," 1993 Annual Meeting, Geological Society of America, Boston, Massachusetts, 25 October 1993.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Trace Element Sources and Sinks in the Chesapeake Bay: Concentrations in the water, organisms and sediments," 1993 JHU/APL Technical; Symposium, 2-3 November 1993.

CORRELL, Francis D. And Douglas W. EDSALL, Professors, "Trace Element Concentrations in water, biological and geological samples from the Annapolis Area, Chesapeake Bay," 1993 Fall Meeting, American Geophysical Union, San Francisco, California, 7 December 1993.

CORRELL, Francis D., Professor, "PIXE Analysis of Artifacts from St. Mary's City," 1994 Middle Atlantic Archaeological Conference, Ocean City, Maryland, 9 April 1994.

EDMONDSON, Charles A., Liuetenant Commander, USN, "Demonstrations of Coupled Oscillators," Acoustical Society of America, MIT, Cambridge, Massachusetts, 9 June 1994.

EDSALL, Douglas W., Professor, "Rapid Characterization of Mediterranean Sea Floor Acoustic Domains Using Digital Bathymetry - based Shaded 3-D views," Ocean Sciences Meeting, San Diego, California (by abstract) 21-24 February 1994.

EDSALL, Douglas W. And Francis D. CORRELL, Professors, "Trace Elemental Analyses of Artifacts from St. Mary's City - The First Year's Effort," 1994 Middle Atlantic Archaeological Conference, Ocean City, Maryland, 9 April 1994.

EDSALL, Douglas W., Professor, "Recent archaeological findings at Historic St. Mary's City - utilizing PIXE as a research tool," Public lecture in conjunction with National Chemistry Week, Anne Arundel Community College, 9 November 1993.

EDSALL, Douglas W., Professor, co-presenter, "Micro Challenge," Preparation of 90 second video spot for incorporation. Conceived, directed, produced and dubbed highlights of proton-induced x-ray emission (PIXE) research for use at Technology 2003 Conference in Anaheim, California, 7-9 December 1993

ELDER, Samuel A., Professor, co-presenter, "Acoustics Teaching at the Naval Academy," 126th Meeting of the Acoustical Society of America, Denver, Colorado, 7 October 1993.

ENGLE, Irene M., Associate Professor, co-presenter, "Modele Empirique De La Magnetoshpere De Saturne," presented in Giens, France at a meeting of the French Space Plasma Physicists "GDR Plasmae" (research group for plasma), 12-15 October, 1993.

ENGLE, Irene M., Associate Professor, "Diurnal Variation in Jovian Subsolar Magnetopause Position," American Geophysical Union, San Francisco, California, December 1993.

ENGLE, Irene M., Associate Professor, "Ulysses Plasma Observations in the Jovian Magnetosheath," American Geophysical Union, San Francisco, California, December 1993.

ENGLE, Irene M., Associate Professor, "Idealized Saturn Magnetosphere Shape and Field," Pole Nationale de Planetologie, Toulouse, France, 13-16 June 1994.

ENGLE, Irene M., Associate Professor, "Planetary Magnetospheres," Pole Nationale de Planetologie, Toulouse, France, 13-16 June 1994.

ENGLE, Irene M., Associate Professor, "Construction d'un Modele Auto-Coherent de L'Equilibre des Magnetospheres de Jupiter et de Saturne," Pole Nationale de Planetologie, Toulouse, France, 13-16 June 1994.

ERTEL, John P., Associate Professor, "Interactive Physics II," Summer Meeting of the American Association of Physics Teachers, Boise, Idaho, 7-14 August 1993.

FONTANELLA, John J., Professor, "Complex Impedance and NMR Studies of Charge Transport in NAFION Membranes," 4th International Symposium on Polymer Electrolytes, Newport, Rhode Island, 19-24 June 1994.

FONTANELLA, John J., Professor, "The Dielectric Properties of Fluoropolymers," ACS Symposium on Dielectric Analysis of Polymers, San Diego, California, 13-18 March 1994.

HUDDLE, James R., Associate Professor, "Moon '93: A Lunometry Project," American Association of Physics Teachers Winter Meeting, San Diego, California, 3-8 January 1994.

JACKSON, Bruce M., LCDR, USN, "Human Computer Interface for Sealift 2005; The Intelligent Ship," ASNE Symposium on Intelligent Ship Design, Philadelphia, Pennsylvania, 1 June 1994

KORMAN, Murray S., Professor, "Laboratory Experiments at the U.S. Naval Academy," The 126th meeting of the Acoust. Soc. of Am., Denver, Colorado, 4-8 October 1993.

KORMAN, Murray S., Professor, "Determination of Turbulent Velocity Correlations by the Nonlinear Scattering of Crossed Ultrasonic Beams," The 126th meeting of the Acoust. Soc. of Am., Denver, Colorado, 4-8 October 1993.

KORMAN, Murray S., Professor, "Computer Graphic Simulations of Microscopic Particle Collisions for Determining Macroscopic Thermodynamics Along a

Path," The 127th meeting of the Acoust. Soc. of Am., Cambridge, Massachusetts, 6-10 June 1994.

KORMAN, Murray S., Professor, co-presenter, "Demonstration of Coupled Oscillators," The 127th meeting of the Acoust. Soc. of Am., Cambridge, Massachusetts, 6-10 June 1994.

KORMAN, Murray S., Professor, "Demonstrations on the Nonlinear Scattering of Crossed Focused Sound Beams in the Presence of Turbulence," The 127th meeting of the Acoust. Soc. of Am., Cambridge, Massachusetts, 6-10 June 1994.

MOSCA, Eugene P., Associate Professor, "The Voltaic cell - How it Works," AAPT Winter Meeting, San Diego, California, January 1994.

MOSCA, Eugene P., Associate Professor, co-presenter, "Introducing Faraday's Law," 1994 APS/AAPT Joint April Meeting, Washington, DC, April 1994.

NORDLING, David A., Professor, "Using Lab VIEW on Student Physics Laboratory Work Stations," American Association of Physics Teachers Summer Meeting, Boise, Idaho, 7-14 August 1993.

TANKERSLEY, Lawrence L., Professor, co-presenter, "Introducing Faraday's Law," 1994 APS/AAPT Joint April Meeting, Washington, DC, April 1994.

VANHOY, Jeffrey R., Associate Professor, co-presenter, "Fragmentation of Isovector Strength in ^{142}Ce," Bull. Am. Phys. Soc. 38, 1818 (1993). Asilomar Conference Center, Pacific Grove, California, 21-23 October 1993.

WINTERSGILL, Mary C., Professor, "Complex Impedance and NMR Studies of Charge Transport in NAFION Membranes," 4th International Symposium on Polymer Electrolytes, Newport, Rhode Island, 19-24 June 1994.

WINTERGILL, Mary C., Professor, "The Dielectric Properties of Fluoropolymers," ACS Symposium on Dielectric Analysis of Polymers, San Diego, California, 13-18 March 1994.

Division of
Professional Development

Captain David L. Peck, USN
Director

Leadership and Law

Commander Robert A. Gurczynski, USN
Chair

Members of the Department of Leadership and Law continued research aimed at understanding ethical development and its relation to midshipman behavior and subsequent performance in the active Naval Service. Research accomplished during the 1993-1994 academic year included: Dr. Karel Montor's completion of an ethics book for junior officers and development of an ongoing student-generated test bank; Dr. Roush's studies of practical curriculum development and further refinement of MBTI analysis related to midshipman and officer performance; and Dr. Barry's look at the possible interactive effects of religious commitment and personality profile on military leadership characteristics in the formation of military officer candidates, and the extent of cooperation between University Counseling Centers and their Chaplain counterparts. The publications and presentations of the staff have further expanded the department's role in leading the Naval Service in matters dealing with leadership instruction and development, and represent our commitment to providing every midshipman a Total Quality Education.

Sponsored Research

Ethics for the Junior Officer

Researchers: Professor Karel Montor and Division of Professional Development Faculty
Sponsor: U.S. Naval Academy Class of 1964

Within the Leadership and Law Department, and commissioned by the U.S. Naval Academy Class of 1964, a volume on Military Ethics was completed and presented to the Class of 1994 at their Dining-In Ceremony, during which Vice Admiral Stockdale, Secretary of the Navy Dalton, Superintendent Rear Admiral Lynch, and class of 1964 President Rear Admiral Sutton were the guest speakers. Actual cases involving ethics decisions were collected from all branches of the Armed Forces. Visits to several military sites were conducted and after write-up of the case by the principal researcher, they were reviewed by a team that represented various branches and services of the military. A novel method of presentation was developed which guides the reader through ethical considerations and interferes with an immediate determination of what happened and thus minimizes a misinterpretation of the ethical point being enunciated. This book will be issued to each graduating midshipman, starting with the Class of 1994, and excerpts of the book will be used in one or more of the leadership classes at the Academy.

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Exam Bank Development

Researcher: Professor Karel Montor
Sponsor: Department of Leadership and Law

Starting in the second semester of academic year 1992-93 and continuing through both semesters of academic year 1993-94, a technique was worked out whereby midshipmen generate test questions covering course material. The question bank, which all students can access, provides the Department of Leadership and Law with some questions for use on the 6-week, 12-week, and final exams. The approach is to have midshipmen submit questions via computer for each homework lesson, noting the lesson title, page, and line number from which the question was taken. The question is then stated in a multiple choice approach and is followed with an explanation of why the right answer is the best answer and why the other answers are either wrong or less inclusive compared to the "right" answer. A serendipitous finding was that, generally speaking, those who entered their questions on time did better on the course-wide tests, possibly giving a somewhat subjective analysis of their followership capabilities.

Independent Research

Interactive Effects of Religious Commitment and Personality Profile in the Development of Successful Military Officer Trainees

Researchers: Assistant James F. Barry and Sheila M. Barry

This study focuses on military leadership, particularly in the formation of military officer candidates. It examines the possible interactive effects of religious commitment and personality profile on military leadership characteristics of students at the Naval Academy. The students are in their sophomore, junior or senior years of college. The 16 Personality Factors Test (16 PF), Cattell, 1950 was completed by all subjects when they reported as freshmen. The measure of religious commitment will be behavioral-based (i.e. attendance at liturgy). This study will be limited to Roman Catholic participants in order to control for the effects resulting from differences among denominations as to definitions of liturgy attendance. The measure of leadership will be the company performance which is assigned at the end of both of the semesters. Each midshipmen is assigned to the top third, middle third or lower third of his or her class within the company.

Chaplains' Evaluations of University Counseling Centers: "Would You Refer a Student?"

Researchers: Assistant Professor James F. Barry and Dr. Mike Moran

A review of the literature indicated a paucity of studies dealing with religious issues and university students. The review also indicated that chaplains had not been canvassed as to their perceptions of traditional mental health professionals. A mail questionnaire was sent to university chaplains at both religious and non-sectarian universities, asking the members of the campus ministry what their opinions were of their own campus counseling center. They were also asked if they would refer students to the campus counseling centers and, conversely, would the counseling center refer students to the chaplains' center. The results are currently being tallied with the goal of studying how these two groups function together. The researchers hope to find out whether they work as a team, referring students between them based on the individual needs of the students, or whether they see each other as competitors. Preliminary results indicate a relatively low level of cooperation.

Naval Law

Researchers: Lieutenant Commander Alan G. Kaufman, USN,
Lieutenant Brent G. Filbert, USN, and Law Section Faculty

The purpose of this research is to develop a text book for midshipmen in the area of military naval law. The goal of the book is to provide midshipmen with the basics in military law in such a manner that is interesting and thought-provoking. The areas covered include: military investigations; history of military law; military crimes; government ethics; nonjudicial punishment; courts-martial; search and seizure; self-incrimination; apprehension and restraint; environmental law; international law; law of the sea; law of armed conflict; prisoners of war; and war crimes. The research has included review of relevant military cases, statutes, regulations, law review articles, treaties, and international agreements. Thus far, the chapter relating to government ethics has been completed and distributed to midshipmen in NL400: Law for the Junior Officer.

The USNA Class of 1980

Researchers: Professor Karel Montor and Mr. Douglas L. Afdahl

In the summer of 1976 neurological measurements were taken of the entering Plebe class along with other data including: psychological test scores, fractionated blood analysis values, color perception results, measurements of handedness, SAT verbal scores, SAT math scores, reading and vocabulary scores, and a test of written English scores. During the following four years, other data were collected on the class including all semester grade point averages, and military performance physical education, and conduct grades. During academic year 1993-94 the original neurological testing equipment was acquired and placed in Luce Hall and the above data was recovered from the Academy's computer data files. During the next three years this data will be correlated with the experiences of these members of the Class of 1980, including their performance in the Fleet, civilian life, and while midshipmen at the Academy. One result of this data analysis is known and was so noted in a memo dated 22 June 1981. It concluded that there were statistically significant differences between men who smoke and those who don't.

Applications of Psychological Preferences in the Military

Researcher: Associate Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. The purpose of the research is to assess how knowledge of psychological preferences can be used in the military in the many manifestations of "know yourself, know your people, know your job." The primary research instrument is the Myers-Briggs Type Indicator (MBTI). The effort thus far has resulted in more than fifteen thousand administrations of the instrument and development in conjunction with computer services of five computer programs for scoring the MBTI, accessing the data, and linking it to a wide range of variables. The study has included analysis of MBTI associations with leadership feedback, counseling feedback, transformational and transactional leadership, voluntary attrition, time management, preference stability over time, and accuracy of self-assessment. It has resulted, to date, in seven presentations: one at a leadership research conference at the University of Maryland, three at regional conferences, one at an international conference of the Association for Psychological Type, one at the institutional research conference of the service academies, and one at the bi-annual leadership conference of
the Center for Creative Leadership. Thus far, the project has resulted in the publication of articles in the *Journal of Psychological Type, Military Psychology* and a chapter in an edited book, *The Impact of Leadership.* Leadership curricula and materials have been modified for the inclusion of MBTI theory and practice in two leadership courses taken by all midshipmen, to increase their understanding of the meaning and importance of individual differences. During Academic year 1993-1994 Third Class midshipmen completed an expanded version of the MBTI, the Expanded Analysis Report (EAR), and received the interpretation during the new Third Class leadership course, NL202: Developing

Subordinates. This marks the second year that the expanded version was integrated into the leadership curriculum. To date, presentations have been made locally to the faculties of three departments: English, Language Studies, and History, in order to acquaint those faculty members with the use of the MBTI to account for differing learning styles as a function of type differences. Local programming support for the MBTI research project is provided by Julie Palmer in Computer Services.

Enhanced Leadership Development

Researcher: Associate Professor Paul E. Roush

This project began in September 1987. *Phase One* of the research project involved development of NL301, a summer leadership course taken by all midshipmen. The course required each Second Class midshipman to subject the plebe development program to a more rigorous and systematic scrutiny than had been the case prior to NL301. The course injected planning into that process and served as a rational counterpoise to the traditional approach of simply requiring new plebes to repeat the upperclassmen's plebe experiences. In another aspect of NL301, class sessions were set aside for analysis by the midshipmen of very difficult problems facing the brigade. Midshipmen recommended solutions which, in turn, were screened, compiled, and forwarded for consideration by the Commandant. *Phase Two* of the project involved development of linkages between the classroom leadership work and the practical leadership experience in Bancroft Hall. Initially, that involved writing-projects which provided valuable feedback concerning the leadership experiences, from both the leaders' and the followers' perspectives. During academic year 1990-1991 the process was further expanded. The plebes used their personal computers to respond anonymously on three occasions to questions dealing with the leadership practices of the second classmen in their respective squads. On two occasions, after the upperclass had assessed themselves using the same criteria, the ratings supplied by the plebes were provided to the upperclass (in the form of aggregated data) as constructive feedback, during the second class leadership course in the spring semester. The feedback was the catalyst for significant changes in leadership behavior and in self-perception among many of the Second Class midshipmen. This phase of the project yielded linkages between leadership feedback and the MBTI, and was the basis for two presentations in July 1991, one at the International Conference of the Association for Psychological Type and the second at the bi-annual research conference of the Center For Creative Leadership. *Phase Three* involved having the Second

Classmen , in only one of the six battalions, receive different leadership instruction from that provided all the other battalions in the Spring 1991 semester. The special instruction emphasized a particular counseling approach, and required significant documentation of the counseling process as part of the course work. The Second Class midshipmen involved were rated by the plebes as making significantly greater improvement in positive leadership practices than were the Second Class midshipmen in the other battalions. That counseling program was instituted brigade-wide beginning in the 1991-1992 academic year. The leadership feedback program provided objective evidence that the fourth class perceived upperclass leadership in 1991-1992 as being more positive in all thirty-two categories, than was the case a year earlier. In academic year 1992-1993 the positive trend continued. The leadership behavior of the second class moved further in the direction of the thirty-two criteria than had been the case with their two predecessor classes. The evidence that behavior changes in the direction of evaluative criteria is very strong. *Phase four* of the project will have all three underclasses evaluating the leadership behaviors of the first-class squad leaders, using as criteria approximately 35 behaviors derived from the USNA leadership model (based on the five leader roles developed by Admiral James Stockdale) as soon as programming resources can be allocated. A preliminary effort was conducted in one battalion this spring with the data collection and analysis under the cognizance of Professor William Bowman. His initial results lent credence to the hypothesis that leadership feedback can move behaviors in the direction of the feedback criteria. The intent is to expand the program into the remaining five battalions as soon as possible. Local programming support for the Leadership Feedback project was originally provided by then Lieutenant Blake Bush, USN, of the Professional Development Division. In an expanded version, the programming support is now under the auspices of Julie Palmer of Computer Services.

Use of Time by Midshipmen

Researcher: Associate Professor Paul E. Roush

This research project, ongoing on a bi-annual basis since 1990, is an expanded version of one conducted in 1989 by Dr. Montor of the Leadership and Law Department. The project involves stratified-random sampling of approximately a fourth of the brigade in the fall semester and again in the spring semester to survey time use by the members of the brigade. Midshipmen respond, using their personal computers, by distributing into 34 categories the 168 hours that constitute a week. The results are analyzed in order to assemble evidence regarding potential initiatives and to assess the effectiveness of previous initiatives intended, for example, to put limits on certain activities and to maximize time available for study. Data is analyzed to ascertain time-use differentials by classes, by athletes versus non-athletes, by gender, QPR, major, service selection and other variables. Local programming support for the Leadership Feedback project was originally provided by then Lieutenant Blake Bush, USN, of the Professional Development Division. In an expanded version, the programming support is now under the auspices of Julie Palmer of Computer Services. Following the Fall 1993 time study this research project has been shifted to the Office of Institutional Research.

Midshipmen Values Assessment

Researcher: Associate Professor Paul E. Roush

This research project involves having midshipmen respond on a survey about the values they hold. The survey began with the Class of 1995. It is done upon entry during the first week of Plebe Summer, upon completion of Plebe Summer, at the end of Plebe Year, midway through Third Class year at the end of Second Class year and prior to graduation, during First Class year. At the conclusion of Academic Year 1993-1994 the Class of 1995 had taken the survey five times, the Class of 1996 four times, and the Class of 1997 three times. The values survey was developed by the Institutional Research Office at West Point and has been in use there for more than a decade. The results of the survey administrations will enable researchers to assess the effectiveness of values inculcation during Plebe Summer and all of Plebe Year. In addition, the survey should be able to track the maturation of values as midshipmen progress through the four-year curriculum. Another potentially rich area for related research is correlational studies in which values are linked with a series of other variables. Finally, survey results are being compared with those at West Point to ascertain if changes follow the same pattern (are comparable in magnitude and direction) at both institutions.

Publications

MONTOR, Karel, Professor, *Ethics for the Junior Officer*, Annapolis, Maryland: Naval Institute Press, (1994).

Includes selected cases from current military experience, along with major articles by seven military personnel with an introduction by the Secretary of the Navy.

Presentations

BARRY, James F., Assistant Professor, with Paul ROUSH, Associate Professor, "Type, Leadership Feedback, and Willingness To Change," MBTI and Leadership International Conference, National Leadership Institute, University of Maryland, 13 January 1994.

MONTOR, Karel, Professor, "Junior Officers Know When They Are Not Ethical in Their Actions and Formal Study of Philosophy Will Rarely Affect Their Behavior," Joint Services Conference on Professional Ethics, Washington, DC, 28 January 1994.

MONTOR, Karel, Professor, "Ethics For The Junior Officer," University of Pennsylvania NROTC Unit, Philadelphia, Pennsylvania, 24 March 1993.

ROUSH, Paul E., Associate Professor, "Gendered Culture in the U.S. Navy and the Creation of a Leadership Cadre," Conference on Institutional Change and the U.S.

Military: The Changing Role of Women, Cornell University, Ithaca, New York, 13 November 1993.

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SCHLEGEL, Robert M., Lieutenant Commander, USN, "Managing the Dual Allegiance to Department of Defense and the American Psychological Association: A Damage Control Perspective." American Psychological Association Annual Convention, Toronto, Canada, August 1993.

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This annual report summarizes the research work of the Naval Academy faculty and midshipman for the period July 1993 through June 1994. Sponsored and independent research projects are listed by title, followed by the names of the investigators and an abstract. A list of publications and their abstracts are included as well as presentations at professional meetings, conferences, and seminars.

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